EXHIBIT M

Michael Baker
INTERNATIONAL

FExpert Opinion Report of J. Michael Trapp and Joel. E. Bowdan III

City of Spokane v. Monsanto Company, et al.

We Make a Difference

J. Michael Trapp, Expert Witness

Joel E. Bowdan III, Expert Witness

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5 ACRONYMS AND ABBREVIATIONS

BMPs	best management practices
City	City of Spokane
$CBOD_5$	5-day carbonaceous biochemical oxygen demand
CCU	Coastal Carolina University
CEPT	chemically enhanced primary treatment
CSO	combined sewer overflow
CSS	combined sewer system
CWA	Clean Water Act
DO	dissolved oxygen
DOH	Washington State Department of Health
Ecology	Washington State Department of Ecology
HHC	human health criteria
HRC	Hubbell, Roth & Clark, Inc.
MBR	membrane bioreactors
MG	million gallons
MGD	million gallons per day
MS4	Municipal Separate Storm Sewer System
NCHRP	National Cooperative Highway Research Program
NLT	next level of treatment
NPDES	National Pollutant Discharge Elimination System
NTR	National Toxics Rule
OEHHA	Office of Environmental Health Hazard Assessment
PCB	polychlorinated biphenyl
RO	reverse osmosis
RPWRF	Riverside Park Water Reclamation Facility
RPWRF/CSO Permit	City of Spokane NPDES Permit for the RPWRF and CSOs

Stormwater Permit	NPDES Eastern Washington Phase II Municipal Stormwater Permit
SWMP	Stormwater Management Program
Task Force	Spokane River Regional Toxics Task Force
TMDL	total maximum daily load
TP	total phosphorus
USEPA	United States Environmental Protection Agency
WLA	waste load allocation
WWTP	waste water treatment plant

SUMMARY OF PRINCIPAL OPINIONS

Trapp's Opinion 1 - Polychlorinated biphenyls (PCBs) are a constituent of concern in the Spokane River and cause impairments to beneficial uses in the river.

Trapp's Opinion 2 - Due to ownership of stormwater collection system and wastewater collection/treatment system (municipal separate storm sewer system [MS4], combined sewer system [CSS], and Riverside Park Water Reclamation Facility [RPWRF]), the City is obligated to respond to regulatory requirements related to discharges of PCBs to the Spokane River.

Trapp's Opinion 3 – Discharges of stormwater runoff via City-owned and -operated MS4 are significant sources of PCBs to the Spokane River and contribute to the impairments to the beneficial uses in the river.

Trapp's Opinion 4 – As the owner and operator of the MS4, the City is and will continue being required to eliminate stormwater discharges from City-owned and -operated MS4 to the river in order to comply with the Human Health Criteria (HHC) for PCBs.

Trapp's Opinion 5 – To fully eliminate the discharge of PCBs from the City's MS4, as is required to comply with the HHC and corresponding regulations, the City of Spokane will incur costs of $288,867,330. In addition, the City will incur $1,626,000 in costs associated with 30-year monitoring.

Bowdan's Opinion 1 – Discharges of untreated combined sewage overflow (CSO) via City-owned and -operated CSS and treated effluent from the RPWRF are historically significant sources of PCBs to the Spokane River and contribute to the impairment of beneficial uses in the river.

Bowdan's Opinion 2 – As the owner and operator of the CSS and RPWRF, the City is and will continue to be obligated to reduce and eliminate PCB discharges to the river from the City-owned and -operated facilities toward compliance with the PCB HHC.

Bowdan's Opinion 3 – Due to City's ownership of the CSS and RPWRF, the city is required to mitigate their contributions of PCBs to the river via discharges from the city-owned and -operated CSS and RPWRF.

Bowdan's Opinion 4 - Due to City's ownership of the CSS and RPWRF and the requirement that the City mitigate their contributions of PCBs, the City of Spokane will incur ongoing operation and maintenance costs starting at $942,610 annually to maintain maximum PCB removal through the Non-Critical Season. Over a 30-year analysis period, the City will incur a total present worth cost of $29,782,000 to provide operation and maintenance of the Next Level Treatment (NLT) through the Non-Critical Season.

Trapp's Opinion 6 – City's mitigation actions to reduce/eliminate PCB discharges from City-owned and -operated MS4, CSS, and wastewater treatment plant (RPWRF) will bring reduction of PCB loads from the City to the Spokane River and help to restore the beneficial uses impaired by PCBs.

1. INTRODUCTION

1.1. SCOPE OF WORK

J. Michael Trapp and Joel E. Bowdan III at Michael Baker International have been retained by Baron & Budd, P.C. to provide expert consultation and analysis in connection with actions that were taken by the City as an owner and operator of the MS4, waste water treatment plant, and CSS regarding impairments caused by PCBs in the Spokane River.

The following is our written report and contains our opinions and their bases, information considered in forming the opinions, and exhibits supporting my opinions. This report is based on information from documents provided by Baron & Budd, P.C. and the City, as well as other publicly available documents. The documents I refer to in this report are listed in Section 4: References.

We understand that this matter is in ongoing litigation; therefore, we reserve the right to update, supplement, or amend my opinions, if, and/or when, additional information or data becomes available for my review and analysis, including any information provided by Monsanto or Monsanto's experts. In addition, we reserve the right to supplement my opinions with demonstratives that could be used at trial.

1.2. QUALIFICATIONS FOR J. MICHAEL TRAPP

The qualifications which justify the expertise to make the opinions stated in this report result from my formal education as well as my 18 years of professional experience in the public, private, and university sectors, as discussed below.

My educational credentials include a Bachelor of Science degree in biology and chemistry from Florida Southern College, which included a study year abroad at the University of Bristol, U.K. My postgraduate degrees including a Master of Science degree in chemistry from University of Miami, and a PhD in marine and atmospheric chemistry from Rosenstiel School of Marine and Atmospheric Science at the University of Miami. My graduate research at the University of Miami focused on the transport and effects of anthropogenic pollutants to the ocean and their potential effects on the food web.

Following my graduate studies, I completed an internship with the US Environmental Protection Agency's (USEPA) National Enforcement Investigations Center in Lakewood, Colorado, where I conducted investigations utilizing advanced analytical methodologies to chemically fingerprint pollutant sources from around the world for federal environmental cases.

I also served as a faculty member and the director of the Environmental Quality Laboratory at the Coastal Carolina University (CCU) Burroughs & Chapin Center for Marine and Wetland Studies. While at CCU, I led a research program anchored by a certified laboratory for environmental monitoring. My research agenda centered around terrestrial pollutant fate and transport to the nearshore ocean and pollutants effects on the beneficial uses, with a heavy emphasis on stormwater as the vector of transport. Additionally, I led numerous monitoring and assessment programs to meet local and regional water quality needs, and supervised and trained technicians, undergraduates, and graduate students in regulatory laboratory and field quality control practices.

In my current role as department manager of surface water and sediment quality at Michael Baker International, I am responsible for the development and management of projects to meet local and regional regulatory compliance requirements. These efforts have helped to define the current and future management strategies for characterizing the risk level and areas to be included in the cleanups, as well as the cleanup and abatement strategies to be employed.

I also serve as the Administrative Officer for the Southern California Stormwater Monitoring Coalition. In this role, I help lead the member agencies in carrying out the coalition's mission to develop the technical foundation to better understand stormwater mechanisms and impacts, and develop the tools that will effectively and efficiently improve stormwater decision-making. As part of my Administrative Officer role, I am leading a five-year study to understand the effectiveness of low-impact development best management practices (BMPs).

My extensive experience in water chemistry, laboratory analysis, pollution chemistry, stormwater projects, and Southern California water and sediment quality regulations allows me to provide expert counsel regarding water and sediment quality. Additional details are available in my curriculum vitae and schedule of fees are included as Appendices A and B.

1.3. QUALIFICATIONS FOR JOEL E. BOWDAN III

The qualifications which justify the expertise to make the opinions stated in this report result from my formal education as well as my 26 years of professional experience primarily in municipal sectors, as discussed below.

My educational credentials include a Bachelor of Science degree in civil engineering from Lawrence Technological University in Southfield, Michigan. My initial focus was in structural engineering and included two years of graduate level work while an undergraduate at the university's state-of-the-art structural testing lab, performing research and testing for projects funded by the National Science Foundation. This hands-on testing and research afforded me the ability to apply theoretical engineering principles and critical analytical skills in developing testing procedures and analyzing test results to present to lead faculty researchers. Additional relevant coursework included chemistry, physics, and environmental and hydraulics engineering.

Upon graduation from Lawrence Technological University, I immediately began working professionally as a staff engineer in the Process Department at Hubbell, Roth & Clark, Inc. (HRC). HRC pioneered much of the current CSO elimination technology in the late 1960s with the design and introduction of retention treatment basins in the Midwest. During my tenure at HRC, I was directly involved in the design, construction management, operation and maintenance manual preparation, start-up, and field performance monitoring of several new retention treatment basins, tunnels, hydraulic structures, regulatory control and pumping facilities designed to eliminate CSOs in the mid to late 1990s. My professional career at HRC included the preparation of wastewater characterization studies, performance of treatment optimization studies, and participation in the design of industrial wastewater pretreatment facilities for several large automotive sector clients. Furthermore, my professional career at HRC included evaluation and design of groundwater treatment and filtration facilities, including the design of several of

the first iron/arsenic oxidation-coprecipitation filtration treatment facilities in advance of the promulgated USEPA Arsenic Rule, and biological high-rate iron removal groundwater treatment facilities.

Upon joining RBF Consulting (now Michael Baker International) in 2004 until the present, my professional experience expanded to include seawater and brackish water desalination using reverse osmosis membranes, electrodialysis reversal, sodium cycle water softening, and quaternary treatment of recycled water (tertiary treated wastewater) for beneficial reuse, and pretreatment technologies for enhancing and increasing the efficiency of potable and non-potable water use and reuse in cooling towers.

In my current role as technical manager of water and wastewater at Michael Baker International, I am responsible for the development and management of infrastructure projects that are designed to meet local, state, and federal water quality requirements. This requires me to stay abreast and current on new and pending regulations, best available treatment technologies, and burgeoning technologies that will allow existing and new water and wastewater facilities to meet increasingly stringent environmental controls and water quality requirements for known existing and emerging contaminants of concern. These efforts have helped define the current and future management strategies for abatement and removal of regulated contaminants from the environment.

My extensive professional experience provides me with the relevant skills and technical background necessary to understand and analyze the operation and optimization of CSO elimination facilities, water treatment facilities, and wastewater treatment facilities. Additional details are available in my curriculum vitae, and a schedule of fees is included as Appendices B and C.

2. BACKGROUND

2.1. PCBS IN THE ENVIRONMENT ARE REGULATED TO PROTECT HUMAN HEALTH AND ENVIRONMENT

PCBs are a group of man-made organic chemicals that were developed in the 1920s and used in a variety of ways. (Erickson and Kaley 2011). PCBs include 209 individual structural compounds known as congeners, distinct subsets of which were commercially manufactured under the trade name Aroclor (NAVFAC 2012). The manufacture of PCBs was banned in the United States in 1979 (ATSDR 2000; McFarland and Clark 1989). While they are no longer produced, they are still found throughout the environment (OEHHA 2018).

Due to PCBs' known harmful effects, federal and state water quality regulations are in place to prevent further contamination and remediate existing PCB contamination. The National Recommended Water Quality Criteria for PCBs regarding water and fish consumption is 6.4×10^{-5} micrograms per liter (µg/L) as total PCBs[1] based on a fish consumption rate of 65 grams per day (g/day) (USEPA 2002). In the state of Washington, the 2016 human health criteria for waters, as promulgated by the US Environmental Protection Agency (USEPA), are 7×10^{-6} µg/L (or 7 picograms per liter [pg/L]) as total PCBs based on a revised fish consumption rate of 175 g/day, which are based on local data from the state (Washington State Department of Ecology [Ecology] 2016). Furthermore, to account for even higher fish consumptions shown in subsistence fishing, the PCB water quality standard becomes much lower to provide the same level of protection: e.g., the Spokane Tribe of Indians in Washington has an even lower PCB water quality standard of 1.34 pg/L as total PCBs based on its subsistence fishing (USEPA 2017a).

The Washington State Department of Health (DOH) issues advice about eating fish from specific waterbodies when chemicals found in certain fish species may harm your health.[2] PCBs are the main driver for the fish consumption advisory placed in the Spokane River for multiple fish species, such as largescale sucker, northern pikeminnow, brown trout, common carp, mountain whitefish, and rainbow trout (DOH 2019; Ecology 2011a).

2.2. PCBS ARE ONE OF THE MOST PERVASIVE AND PERSISTENT CONTAMINANTS IN THE ENVIRONMENT

Due to the numerous uses of PCBs in various products and their extreme stability and resistance to degradation, PCBs became one of the most pervasive and persistent contaminants in the environment (USEPA 2018a). PCBs were first produced in the 1920s and production continued until the 1970s. While properties such as nonflammability, chemical stability, high boiling point, and insulation were applicable to their use in electrical equipment, hundreds of additional uses were found for PCBs, including in common products such as waterproofing materials and colorants in caulking (Ecology 2014a). Historical uses of PCBs include, but are not limited to:

- Electrical transformers and capacitors

[1] Total PCBs are the sum of all congeners, isomers, homologs, or Aroclors.
[2] https://www.doh.wa.gov/CommunityandEnvironment/Food/Fish/Advisories.

- Heat transfer and hydraulic systems
- Machine oils and lubricants
- Cable insulation
- Building materials including grout, caulk, paint, concrete, and wood coatings
- Adhesives and tapes
- Fluorescent light ballasts
- Plastics and rubber products
- Paint and surface coatings
- Pigments and dyes
- Carbonless copy paper
- Pesticides (Ecology 2014a; Erickson and Kaley 2011)

Many of the properties that made PCBs commercially desirable—namely, their stability and resistance to degradation—make them extremely persistent in the environment (Ecology 2011a). Because of this extreme chemical and thermal stability, once they are introduced to the environment, they remain there for years or even decades, cycling between air, water, and soil (ATSDR 2000; USEPA 2018a).

Due to their various uses, pathways of PCBs entering the environment are also numerous. While PCBs were predominantly used in sealed operations (e.g., transformers, capacitors), where any environmental impact expected to occur would be from a leak, accident, or disposal (Erickson and Kaley 2011), PCBs can still be released into the environment from other pathways:

- Hazardous waste sites that contain PCBs
- Dumping or discharge of PCB wastes
- Disposal of PCB-containing consumer products into municipal or other landfills not designed to handle hazardous waste
- Burning some wastes in municipal and industrial incinerators
- Leaching from uses of PCB-containing materials such as sealant or caulking
- Building renovations and demolition (Klosterhaus et al. 2011; USEPA 2018a; USEPA 2018c; Herrick 2007; Sundahl, et. al 1999; Larry Walker Associates et al. 2006; USEPA 1976)

For example, materials such as paint, caulk, grout, cement, and floor coverings containing PCBs have been shown to release PCBs into the environment. Caulk used on building exteriors, and thus exposed to the environment, has been found to have high concentrations of PCBs (Klosterhaus et al. 2011). A study conducted in the San Francisco Bay Area in California found PCBs in 88 percent of exterior caulk samples from buildings selected at random, a finding that is consistent with other studies performed in highly urbanized areas including Toronto, Boston, New York, and Switzerland (Klosterhaus et al. 2014). In the greater Los Angeles area in California, Malibu High School had to turn a remodeling project of the school into a remediation project due to the findings of PCBs in window glazing, door caulking, interior wood, and plaster exterior stucco (Ramboll Environ US Corporation 2016; Alta Environmental 2017), as well as PCBs thought to have migrated from glue used in floor tiles into concrete slabs (SMMUSD 2018). PCBs from one location may migrate to and contaminate another site, prompting costly remediation, as shown in a case in New Jersey where PCB-contaminated concrete was crushed and reused for fill materials: i.e., *Ford Motor Co. v. Edgewood Properties*, 2012 U.S. Dist. LEXIS 125197 (D.N.J. 8/31/12) (Schnapf n.d.).

Furthermore, PCBs in exterior building materials, even when undisturbed, can be leached to the environment and then can be washed off by rain, accumulate in storm drains, and contaminate soil and groundwater. An example is Boeing Plant 2 in Seattle, Washington. The plant was built in the late 1930s. PCBs from transformers and related electrical equipment, as well as hydraulic equipment, paint, and caulk, were released at the plant and into the Lower Duwamish Waterway. As part of the cleanup, Boeing removed nearly a mile of PCB-contaminated joint caulk, cleaned up storm drains to reduce PCBs, removed some contaminated soils, and treated contaminated soils and groundwater under an USEPA Resource Conservation and Recovery Act Administrative order (USEPA 2018c). As another example, PCBs were found to leach from window sealants into surrounding carpets and soils at Youth Services Center Courthouse in Seattle (Ervin 2010). In addition to these examples, numerous cases report that PCBs from interior and exterior building materials were found in surrounding environments and demonstrate that open uses of PCBs in building materials are continuing sources of PCBs to the environment:

- Large amounts of PCBs were found in soil surrounding buildings with undisturbed concrete block sealants or caulking containing PCBs. (Sundahl et al 1999; Herrick et al. 2007).
- PCB indoor air concentrations were elevated in 26 percent of buildings analyzed with joint sealants containing PCBs according to a nationwide study in Switzerland. Concentrations increased with increased room temperature. "Joint sealants represent long-term diffuse sources for PCB." (Zennegg et al. 2004)

PCBs were also used in carbonless copy paper and added to paper in inks and other additives. Due to this, paper recycling releases PCBs into the environment, primarily through effluent water (USEPA 1976; Stratus Consulting Inc. 1999).

Furthermore, PCBs can be produced as a byproduct during processes that involve chlorine, carbon, and high temperatures (Munoz 2007). This includes a process of pigment creation (Christie 2014; Ecology 2014a; Hu and Hornbuckle 2010; Rodenburg 2012). For instance, white pigments (titanium dioxide), yellow, orange, and red products that are derived from azo pigments (monoazo [Hansa Yellows and azonaphthols] and diarylide yellows), phthalocyanine blues, and greens are found to contain PCBs.

2.3. PCBS IN THE ENVIRONMENT ARE COLLECTED AND CONVEYED THROUGH MS4 AND WASTEWATER COLLECTION AND TREATMENT SYSTEMS

The Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972) made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions (USEPA 2017b). A point source "means any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged" (40 C.F.R. §122.2). In the example of the City of Spokane, City-owned and -operated MS4 and wastewater collection and treatment systems, including sanitary sewer only system, CSS, and a wastewater treatment plant (i.e., RPWRF), are all point sources, and

discharges from MS4 outfalls, CSO,[3] and RPWRF effluent outfalls are all subject to National Pollutant Discharge Elimination System (NPDES) regulations.

An MS4 is a conveyance or system of conveyances designed or used to collect or convey stormwater (USEPA 2018d). When rain or stormwater runoff contacts pollutants in the environment such as PCBs, the pollutants can be picked up by the stormwater runoff, transported through the MS4, and discharged into receiving waterbodies: "[p]olluted storm water runoff is commonly transported through municipal separate storm sewer systems (MS4s), and then often discharged, untreated, into local waterbodies" (USEPA 2018d). Furthermore, "[t]o prevent harmful pollutants from being washed or dumped into MS4s, certain operators are required to obtain NPDES permits and develop stormwater management programs" (USEPA 2018d). Due to this reason, certain municipalities who own MS4s, like the City of Spokane, are required to obtain MS4 NPDES permits. According to the USEPA's 2009 assessment, "[r]egulated MS4 area represents 4% of the U.S. land area and >80% of the population" (USEPA 2018d). The City's stormwater discharges are permitted under Eastern Washington Phase II Municipal Stormwater Permit (Ecology 2014b).

A CSS is a conjoined system of (1) stormwater collection from areas such as roads, roofs, and parking lots and (2) raw sewage, which consists of domestic (human, animal and building sourced) wastewater and industrial (manufacturing and industry sourced) wastewater. During heavy rain or snowmelt events, the influx of stormwater to the combined system may overwhelm its carrying capacity. At that time, a CSO event occurs, and a portion of the stormwater-sewage mixture bypasses the local wastewater treatment plants and discharges directly to a receiving waterbody. Because of the variety of uses and the persistency of PCBs in the environment, PCBs that are picked up by stormwater runoff may be discharged to the receiving waterbody during CSO events. Untreated sewage discharge during a CSO event can contain PCBs, as described in Section 2.2.

For this reason, discharges from MS4s and CSOs have been identified as one of the major pathways that transport PCBs from the urban environment to receiving water bodies such the Spokane River (Ecology 2011a). In addition, depending on a level of treatment, treated wastewater discharges from a wastewater treatment plant can be a pathway of PCBs to the receiving water body (Ecology 2011a).

2.4. SPOKANE RIVER AND CITY OF SPOKANE

2.4.1 Spokane River

The Spokane River basin encompasses more than 6,000 square miles (15,500 km^2) in Washington and Idaho. The river begins at the outlet of Lake Coeur d'Alene and flows west 112 miles to the Columbia River (Figure 1). The river flows through the small cities of Coeur d'Alene and Post Falls in Idaho, and through the large urban areas of the City of Spokane Valley and the City of Spokane in Washington. There are seven hydroelectric dams along the Spokane River. Before construction of the dams, members of the Spokane Tribe and other native tribes congregated along the lower Spokane River to fish the spring salmon runs (Ecology 2011a; City of Spokane 2014a).

[3] "Combined sewer overflow (CSO) means a discharge from a combined sewer system (CSS) at a point prior to the Publicly Owned Treatment Works (POTW) Treatment Plant" (40 C.F.R. §122.2).

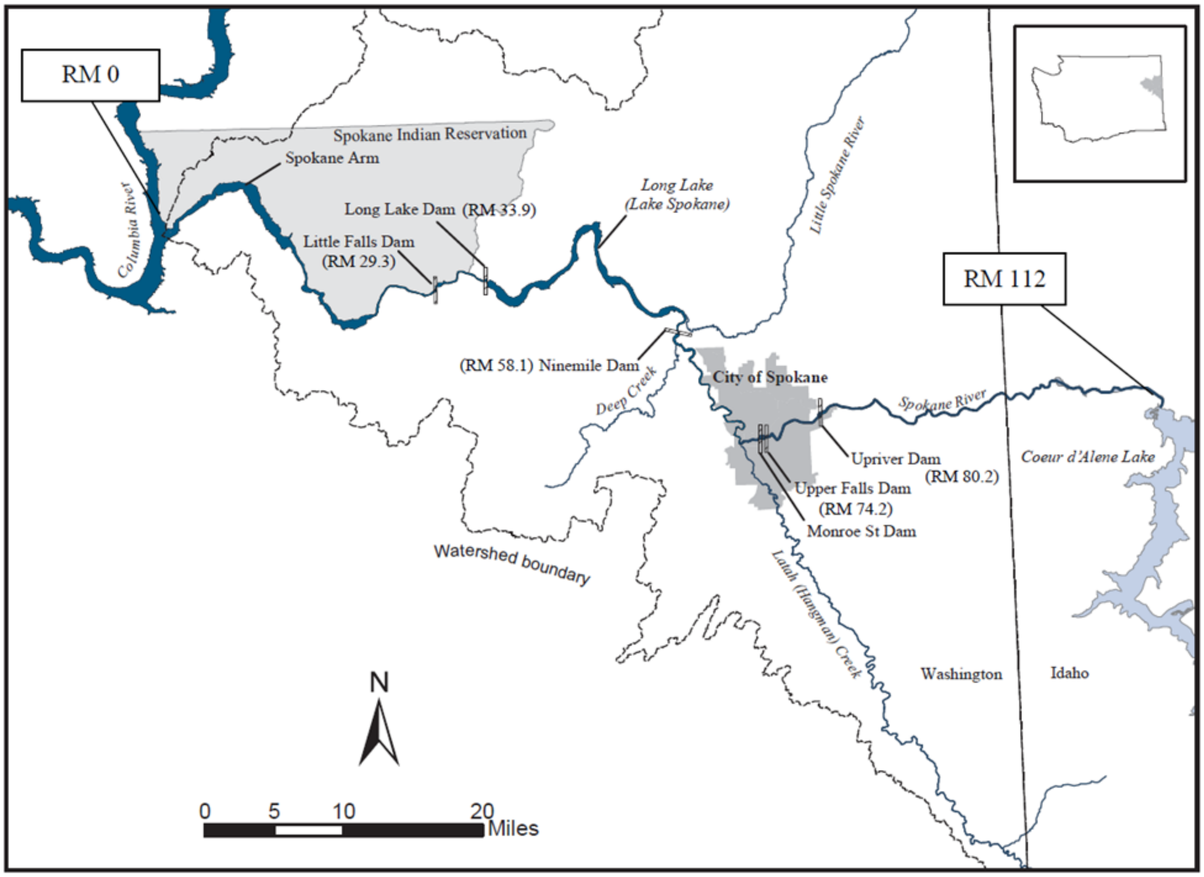

FIGURE 1. CITY OF SPOKANE AND SPOKANE RIVER, WASHINGTON (ECOLOGY 2011A)

The Spokane River serves as habitat and provides protection and food for many species, such as bald eagles, osprey, great blue heron, shorebirds, beaver, moose, redband trout, rainbow trout, brown trout, cutthroat trout, Chinook salmon, and Kokanee salmon. Per WAC 173-201A-602 Table 602,[4] the Spokane River between Nine Mile Bridge (River Mile [RM] 58.0) and Long Lake Dam (RM 33.9) is designated for two beneficial uses: aquatic life use of core summer salmonid habitat and a recreation use of extraordinary primary contact. These two beneficial uses are more stringent use designations than for the section upstream between Nine Mile Bridge and the Idaho border (RM 96.5) (i.e., salmonid spawning/rearing/migration and primary contact; Figure 2; City of Spokane 2014a).

[4] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-201A-602

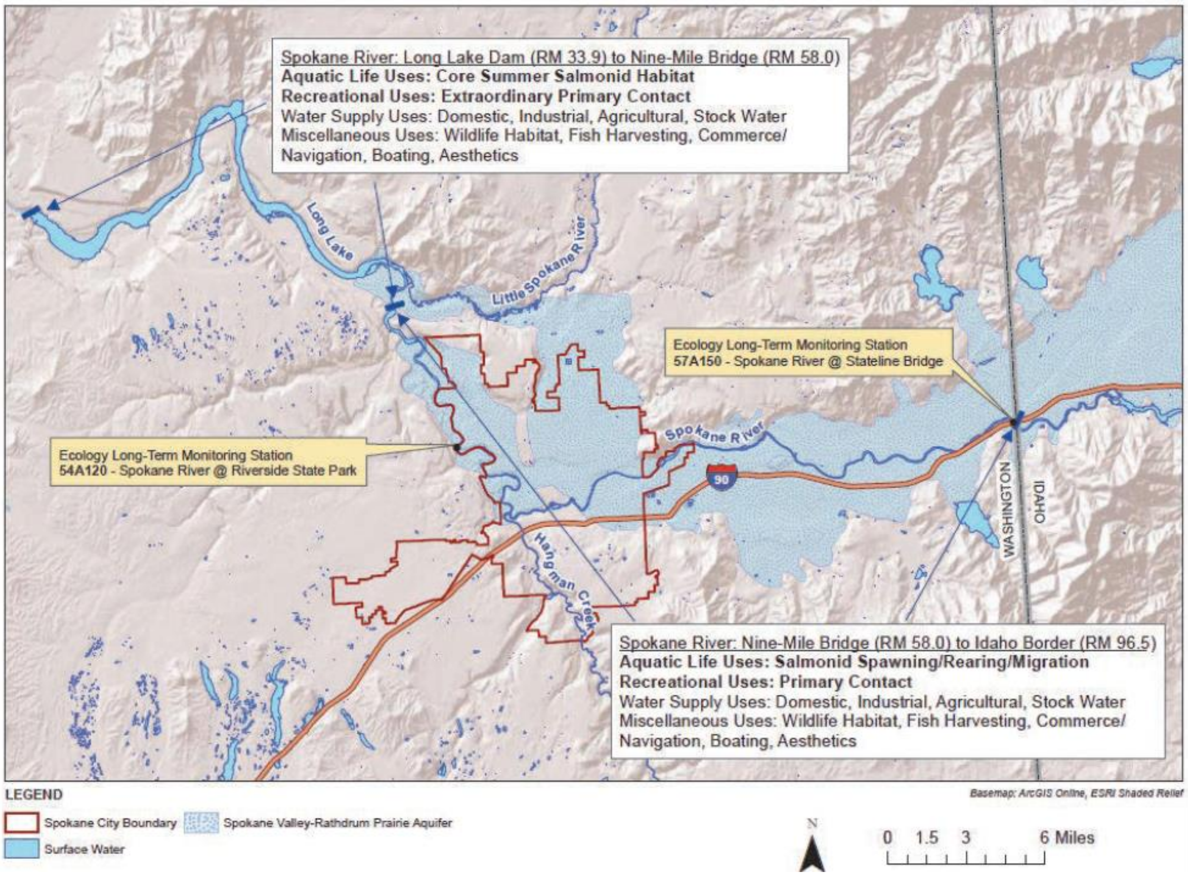

FIGURE 2. USE DESIGNATION FOR THE SPOKANE RIVER (CITY OF SPOKANE 2014A)

Some of the beneficial uses of the river are impaired due to pollutants. In particular, fish harvesting use is impaired due to PCBs. Multiple waterbody segments of the Spokane River, Lake Spokane (also known as Long Lake), and the Little Spokane River are listed as impaired for not meeting Washington State's human health water quality criterion for PCBs in edible fish tissue (Table 1). The impairments are based on concentrations of PCBs measured in fish tissue that exceeded a fish tissue equivalent concentration for applicable water quality standards.

TABLE 1. 303(D) LISTINGS FOR TOTAL PCBS IN THE SPOKANE RIVER BASED ON FISH TISSUE (ECOLOGY 2019A)

Waterbody Name	Listing Identification
Little Spokane River	9051
Long Lake	52665
	52666
Lake Spokane	9015
	9021
	36440
	36441
	78928
	78929
	78930
	78931
	78932
	78933
Spokane River	8201
	8202
	8207
	9027
	9033
	14385
	14397
	14400
	78968

To address PCB impairments in the river, the Spokane River Regional Toxics Task Force (Task Force) was formed in 2012 and developed a plan to bring the Spokane River into compliance with applicable water quality standards for PCBs. The City of Spokane and other dischargers to the river, including the Spokane County, the Liberty Lake Sewer and Water District, Inland Empire Paper Co., and Kaiser Aluminum, have been participating in the Task Force functions as required by the dischargers' NPDES permits (Task Force 2012).[5] The Task Force determined that PCBs "in buildings (i.e., small capacitors, sealants) and legacy soil contamination are estimated to be the largest source areas of PCBs in the [Spokane River] watershed. The primary delivery mechanisms of PCBs to the Spokane River were determined to be cumulative loading across all wastewater treatment plants, contaminated groundwater, and stormwater/combined sewer overflows" (LimnoTech 2016).

[5] Further details on the Task Force and PCB reduction efforts are presented in Section 3 of this document.

2.4.2 City of Spokane

The City of Spokane is located in eastern Washington, about 20 miles west of Idaho and 110 miles south of the Canadian border, and encompasses around 60 square miles. The Spokane River runs through the downtown area and bisects the City. The City was founded in 1873, and became a center of regional commerce when the Northern Pacific Railroad arrived in 1881 and created a transcontinental link in 1883. Gold was discovered in 1883, and mining began in the Spokane region. With decline of mining area, the City turned to lumber and logging. Aluminum production began in the Spokane region around the time of World War II (i.e., Mead Works and Trentwood Works; Downtown Spokane Heritage Walk 2019).

The City owns and operates wastewater collection and treatment systems serving an estimated population of 251,000 people in the Spokane metropolitan area. The wastewater collection and treatment systems include the RPWRF and a complex system of pipes and pumps that collect wastewater and, in some locations, stormwater. Approximately 54 percent of the City is serviced by a separated sanitary sewer system that is not intended to receive any direct stormwater inflow from roof drains and/or catch basins. The remaining 46 percent of the City is serviced by a CSS, about three quarters of which is intended to convey both sanitary sewer flows and stormwater runoff. The remaining one quarter of the area serviced by the CSS contains dedicated sanitary sewers in newer areas that were built without storm connections, but receive stormwater runoff because they are located downstream from areas that have storm connections via the CSS. Rainfall events that cause excessive amounts of stormwater runoff to enter the CSS may result in CSOs. These overflows are discharged to the Spokane River through pipes called CSO outfalls, and consist of a mixture of partially treated stormwater runoff and raw sewage. The City currently has 20 permitted CSO outfalls (City of Spokane 2017). A summary of the City's wastewater collection and treatment systems is presented in Table 2.

TABLE 2. CITY OF SPOKANE'S WASTEWATER COLLECTION AND TREATMENT SYSTEMS (CITY OF SPOKANE 2014A).

Summary of Wastewater Collection and Treatment Facilities in City of Spokane	
Total length of sewer pipe (combined + separated sewer)	871 miles
Length of combined sewer pipe	400 miles
Length of separated sewer pipe	471 miles
Sewer lift stations	27
Inverted siphons (sag pipe facilities)[a]	18
CSO Outfalls	20
Wastewater Treatment Plan Outfalls (includes treated CSO discharge)	1

[a] Two inverted siphons are inactive.

The City also owns and operates an MS4, which serves approximately 22 percent, or nearly 10,000 acres, of the City. Most of the area is located north of the Spokane River (Figure 3). Table 3 presents the components of the City's MS4. The City has approximately 130 stormwater basins—100 draining to the Spokane River and 30 draining to Latah Creek—the majority of which are less than 10 acres in size. The twelve largest stormwater basins (Cochran, Greene, Kiernan, Hollywood, Howard, Lincoln, Mission, Rifle Club, Riverton, Superior, Washington, and Union) make up approximately 85 percent of the MS4 service area. Most of these larger stormwater basins were created in the 1980s and 1990s as part of the City's stormwater separation projects for CSO reduction, and thus overlap with the areas where the separation between the sewer system and the MS4 is incomplete.

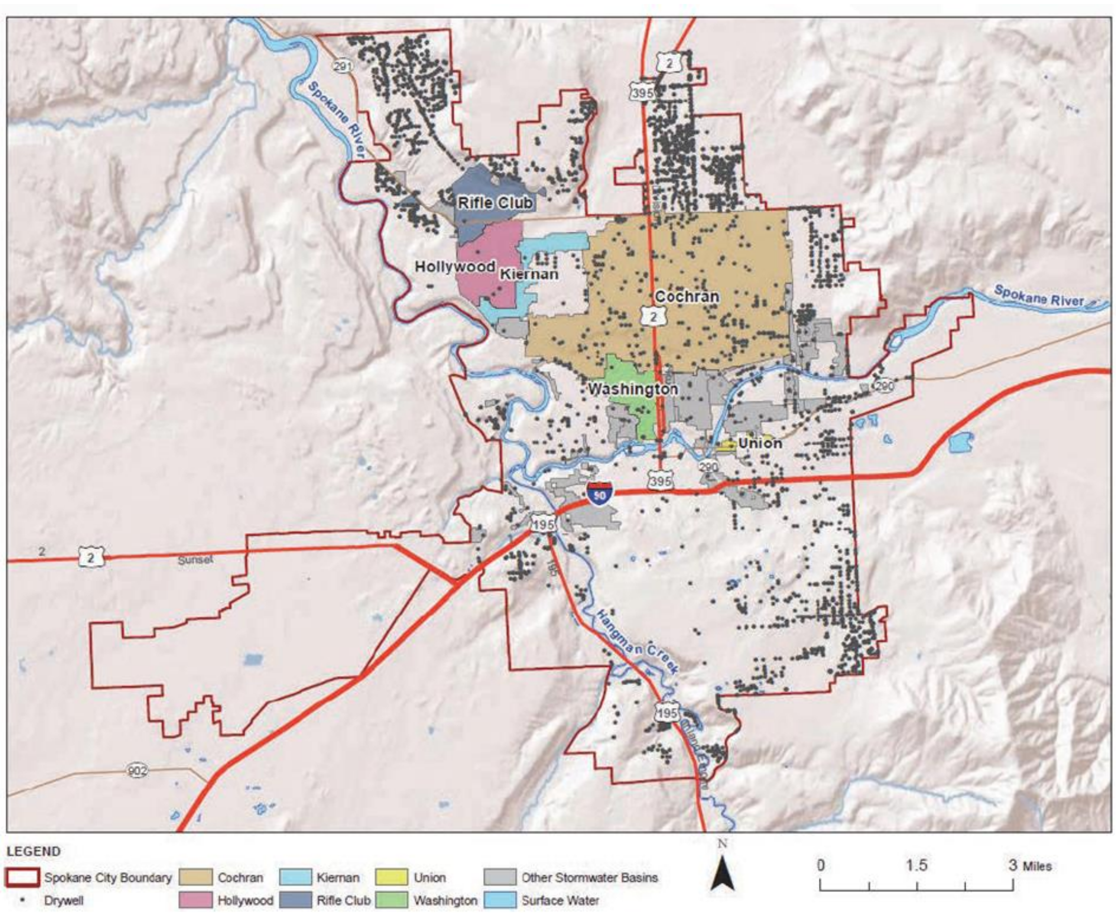

FIGURE 3. CITY OF SPOKANE MS4 AND MAJOR STORMWATER BASINS.

TABLE 3. CITY OF SPOKANE'S MS4 (CITY OF SPOKANE 2014A)

Summary of MS4's in City of Spokane	
Length of Stormwater Pipe	366 miles
Length of Storm Channels	0.5 miles
Stormwater Lift Stations	1
Stormwater Manholes	4,460
Inlets	16,690
Stormwater Outfalls	130
Stormwater Management Facilities	11

As discussed in Section 2.4.1, the City is required to participate in the Task Force functions because the Spokane River is the primary receiving waterbody for discharges from the City-owned and -operated MS4, treated effluent from the RPWRF, untreated CSO discharges from the CSS, and several other point and non-point source discharges. There are 20 NPDES-permitted CSO outfalls in the City (City of Spokane 2017). Ecology determined that the City's discharges of PCBs in stormwater (44%) are the main source of overall PCB load to the Spokane River, followed by PCB loading from Idaho (30%), other municipal and industrial discharges within the Washington reaches of the river (20%), and Little Spokane River (6%) (Ecology 2011a).

Sources of PCB loads via stormwater from the City are likely in City locations with historical industrial land uses (City of Spokane 2014b). There are 23 PCB contamination-related cleanup sites in the City: one awaiting cleanup, one cleanup complete, six cleanups started, one construction complete and under performance monitoring, and 14 with no further action (completed construction and monitoring) (Ecology 2019b). Further details on some of these sites are below:

- City parcel site: The site was previously owned by Spokane Transformer, where transformer repair and recycling caused contamination. Remediation was performed to remove soils with greater than 10mg/kg PCBs (10,000 parts per billion) in 2008. Cleanup was performed only within the boundaries of the site, although the contamination might have extended beyond this limit. Additional sampling was performed to determine these extents in 2014 (City of Spokane 2014b).
- General Electric Corporation Spokane Sullivan site: The site was used as an industrial service house from 1961 to 1980 and then a woodstove and fireplace manufacturing company from 1980 to 1984. Cleanup was performed from 1991 to 1999. The site is currently under periodic review.
- Pacific Steel and Recycling site: The site was identified in 2004 and is awaiting cleanup.
- Spokane Fire Department site: The site was identified in 1990 and listed as a hazardous site in 1994. The opinion on cleanup action was released in 2001.

In addition to the historical use sources, PCB load from the City can be also from various PCB-containing products that may come into contact with stormwater.

3. BASIS FOR OPINIONS

Trapp's Opinion 1 - PCBs are a constituent of concern in the Spokane River and cause impairments to beneficial uses in the river.

1. The Spokane River is on the state of Washington's 303(d) list of impaired waterbodies for PCBs. In particular, the section of Spokane River within the City of Spokane is listed for PCBs in fish tissue as Category 5 which requires a total maximum daily load (TMDL). "The Spokane River does not meet Washington State human health criteria (HHC) for polychlorinated biphenyls (PCBs) in edible fish tissue" (Ecology 2011a).
2. To address the PCB impairments in the river, in lieu of the traditional TMDL process, Ecology and USEPA selected a direct-to-implementation approach, creating the Task Force to make progress toward meeting water quality standards for PCBs (Task Force 2015).
3. The Task Force was formed in 2012 to develop a plan to bring Spokane River into compliance with applicable water quality standards for PCBs (Task Force 2012).
4. The formation of the Task Force was required in Washington State NPDES wastewater discharge permits issued in 2011 by Ecology for facilities discharging into the Spokane River. The permits state that the goal of the Task Force is to "develop a Comprehensive Plan to bring the Spokane River into compliance with applicable water quality standards for PCBs" (LimnoTech 2016). Should the Task Force fail to make measurable progress toward this goal, then Ecology is "obligated to proceed with a TMDL in the Spokane River for PCBs or determine an alternative to ensure that water quality standards are met" (LimnoTech 2016). Participants on the task force include representatives from Spokane County, the Liberty Lake Sewer and Water District, Inland Empire Paper Co., Kaiser Aluminum, Spokane Regional Health District, Washington State Department of Health, the Lands Council, and the Lake Spokane Association in addition to the City. Ecology, USEPA, Idaho Department of Environmental Quality, Spokane Tribe, Coeur d'Alene Tribe, and Avista have advisory roles (Task Force 2019).
5. Washington State Department of Health (DOH) fish consumption advisories are placed for the Spokane River due to PCBs (DOH 2019, 2009); see Figure 4. DOH's evaluation indicates that exposure to PCBs through ingestion of fish caught in the Spokane River represents a public health hazard. PCBs are a driver for the fish consumption advisory in the river, which means PCBs in fish tissue are the limiting factor for the amount of fish that can be safely consumed, and the fish consumption advisory based on PCBs is protective of exposure to other chemicals such as lead and polybrominated diphenyl ethers (DOH 2007). Due to PCB levels found in fish from the river, DOH recommendations for eating fish vary by species from none to one per week to one per month. DOH (2009) also recommends specific fish preparation in order to reduce one's exposure to PCBs when fish from the river are consumed; see Figure 4.

   > "DOH recommends against any consumption of fish between the Idaho border and Upriver Dam. For the reach between Upriver Dam and Ninemile Dam, DOH advises against eating more than one meal per month of any species...any advice provided for fish consumption based on PCBs will also be protective of excessive lead exposure." (DOH 2007)

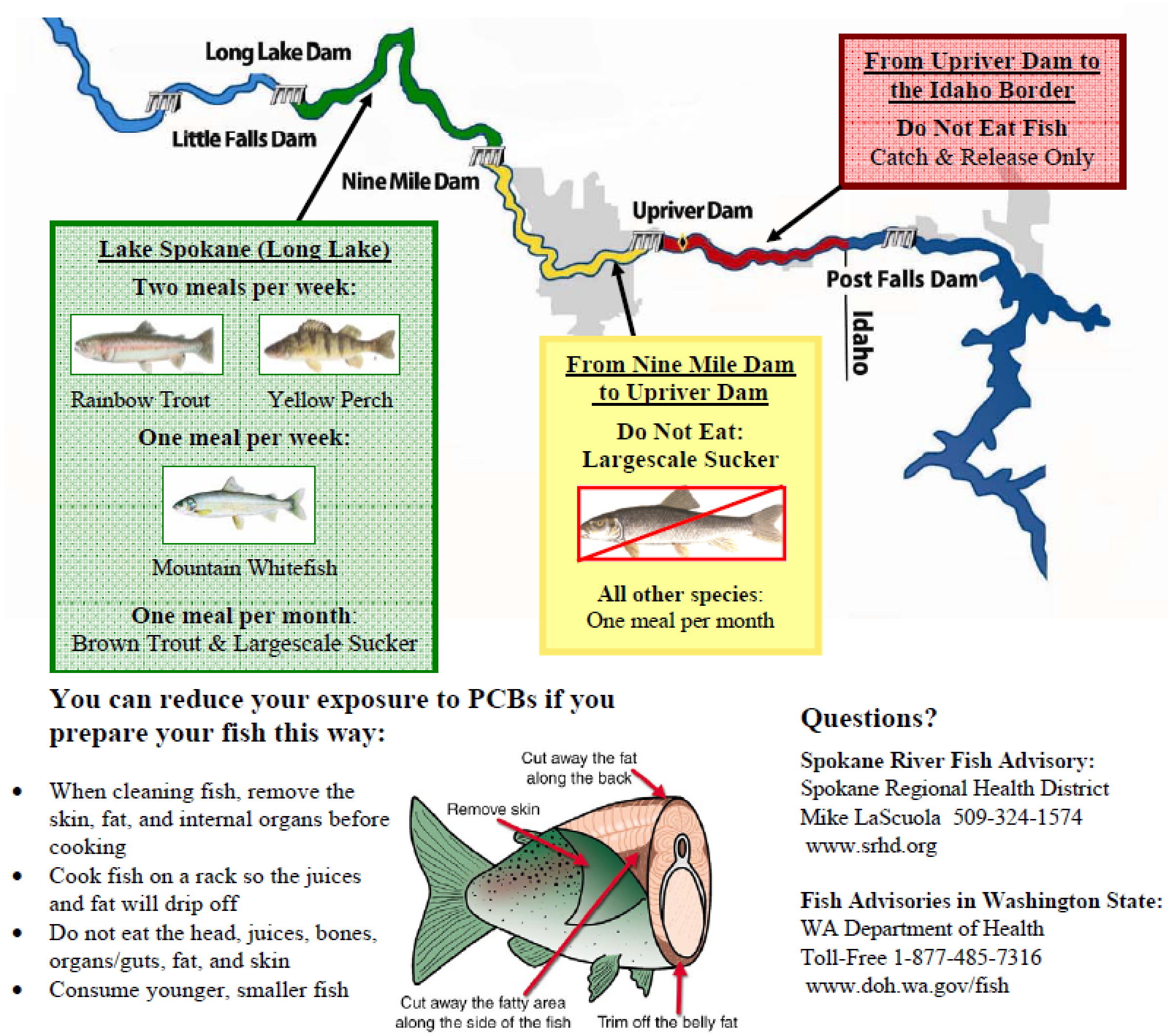

FIGURE 4. DOH FISH ADVISORY FOR THE SPOKANE RIVER (DOH 2009)

6. Surface Water Quality Standards for Washington State (WAC 173-201A –Section 200 Freshwater Criteria): the USEPA federally promulgated HHC in the state of Washington for PCBs is 7 pg/L for both water and organisms and organisms only (Washington State 2016). This is one of the most stringent PCB criteria in the country. Washington State's HHC for PCBs have been revised multiple times due to various reasons as summarized below.
    - USEPA initially promulgated HHC for toxic pollutants applicable to waters in the state of Washington in the 1992 National Toxics Rule (NTR) (USEPA 1992). USEPA amended the HHC for PCBs in 1999 as 170 pg/L for both "water and organisms" and "organisms only."
    - On August 1, 2016, Ecology submitted a package of state-promulgated HHC (WAC 173-201A-240) to USEPA for review and action pursuant to USEPA's authority under the Clean Water Act section 303(c). Ecology adopted 170 pg/L for PCBs which was based on a fish consumption rate of 175 g/day and is associated with a PCB-specific risk level of 2.3×10^{-5} (Washington State 2016). For the 2016 HHC, Ecology had initially elected to use a cancer risk level of $4 \times 10^{-}$

^{5} for PCBs, consistent with the level of risk used by the DOH in developing fish advisories. However, when the 4 x 10^{-5} cancer risk level was applied with its other inputs to calculate PCB HHC, the resulting criteria of 290 pg/L were less stringent than the 1999 NTR values of 170 pg/L. Due to this reason, Ecology decided not to increase the PCB HHC above the NTR value, and instead adopted the NTR value of 170 pg/L by adjusting the cancer risk level to 2.3 x 10^{-5} (USEPA 2016).

- On November 15, 2016, USEPA disapproved 143 of the 192 HHC submitted by Ecology. In particular, USEPA disapproved Ecology's PCB HHC because the state used the 2.3 x 10^{-5} PCB-specific cancer risk level, and instead recommended Ecology use a 10^{-6} cancer risk level and other inputs consistent with USEPA's 2015 304(a) guidance to derive PCB criteria that are protective of designated uses, including the tribal subsistence fishing use as informed by treaty-reserved fishing rights (USEPA 2016). USEPA finalized a federal rule for the 143 HHC that it disapproved, which became effective December 28, 2016: e.g., 7 pg/L for PCB HHC.
- On February 21, 2017, several industry petitioners filed a petition with USEPA, requesting that USEPA reconsider its decision to disapprove portions of the criteria that Ecology submitted in August 2016, and to repeal the rule USEPA promulgated in November 2016 which established Washington's existing HHC. USEPA took no action on the petition for almost a year and a half (Northwest Pulp & Paper Association et al. 2017)
- On August 3, 2018, USEPA sent a letter to the attorney for one of the industry petitioners advising that USEPA had decided to reconsider the regulation it promulgated in November 2016 to establish HHC for Washington (USEPA 2018e).
- In an August 7, 2018 letter, Ecology Director Maia Bellon informed USEPA that the state of Washington opposed reconsideration of USEPA's 2016 rule that established Washington's current HHC and preferred to focus its resources on implementing the HHC (Ecology 2018).
- In a memo dated March 20, 2019, USEPA authorized the posting of EPA-HQ-0W-2015-0174 to Regulations.gov, requesting public comment from April 8, 2019, to May 8, 2019, regarding USEPA's proposal to revise Washington's existing HHC (USEPA 2019a).
- On April 10, 2019, Ecology's news release stated that Ecology and the state of Washington objected to USEPA's reversal and Ecology has communicated with USEPA that "the state opposes any actions that would delay or prevent Washington from continuing to implement the clean water rule." "For more than two and a half years, we've worked with communities, tribes, local governments, and businesses to implement the clean water rule. We fully expect any actions EPA takes now to reverse course will result in costly litigation that benefits no one," said Director Bellon. "It is unnecessary and counterproductive to create this atmosphere of regulatory uncertainty – we already have a path forward that will lead to protective and practical clean water permits" (Ecology 2019c).
- On April 11, 2019, USEPA withdrew its request for public comment on its proposal to revise Washington's existing HHC, stating that the public comment period had been opened in error (Ecology 2019c).
- On May 7, 2019, in a letter to USEPA, Director Bellon noted that there was no legal basis for USEPA to revise Washington's existing HHC, which Ecology had been implementing for over two and a half years; that a revision to the criteria would create regulatory uncertainty and

confusion; and that the state of Washington was steadfastly opposed to USEPA's proposed revision of Washington's existing HHC (Ecology 2019d).

- On May 8, 2019, Washington State Attorney General Bob Ferguson also wrote to USEPA to reinforce the concerns raised by Director Bellon, remind USEPA that the Clean Water Act establishes clear procedures to revise a state's existing water quality standards, and since USEPA had failed to comply with these procedures, there was no legal basis for USEPA to revise Washington's existing HHC (Ferguson 2019).
- On May 10, 2019, USEPA reversed its 2016 disapproval of 141 of Ecology's HHC, including the PCB HHC (i.e., 170 pg/L), and withdrew the current federally promulgated HHC for the 141 HHC, including the PCB HHC (i.e., 7 pg/L for PCBs). According to its letter to Ecology, USEPA reversed its own 2016 decision "[u]nder the EPA's inherent authority to reconsider its prior decisions and in accordance with CWA [Clean Water Act] section 303(c) and the implementing regulations at 40 CFR Part 131" (USEPA 2019b).
- On June 6, 2019, Washington State Attorney General Bob Ferguson filed a lawsuit in US District Court for the Western District of Washington challenging USEPA's decision (Case 2:19-cv-00884). "This case challenges the Environmental Protection Agency's (EPA) unlawful decision to revise the existing water quality standards for the state of Washington without complying with the process Congress established in the Federal Water Pollution Control Act (Clean Water Act or CWA) to revise a state's existing water quality standards."

7. The state of Washington opposes USEPA's revision of the current state's water quality standards and it intends to maintain/implement the current HHC, including the PCB HHC of 7 pg/L. It is expected that the City of Spokane and other NPDES dischargers to the Spokane River are and will be required to continue complying with the PCB HHC of 7 pg/L until the Court ultimately determines otherwise.
8. Regardless of the outcome of the lawsuit filed by the state of Washington, DOH's fish advisory based on PCBs is still in effect, and the PCBs are the main pollutant posing most risk to public health via consumption of fish from the Spokane River as presented previously in Trapp's Opinion 1.5.
9. In addition to the current federally promulgated HHC, the Spokane Tribe of Indians Surface Water Quality Standards are in effect in the river for PCB HHC of 1.3 pg/L as total PCBs for a consumption of water and organisms and organisms only (USEPA 2017a; Spokane Tribe of Indians 2010).

Trapp's Opinion 2 - Due to ownership of stormwater collection system and wastewater collection/treatment system (MS4, CSS, and RPWRF), the City is obligated to respond to regulatory requirements related to discharges of PCBs to the Spokane River.

1. Under the Clean Water Act, the NPDES is a federal requirement that regulates stormwater and wastewater dischargers to waters of the United States. In the state of Washington, Ecology was granted with NPDES regulatory authority.
2. The City, an owner and operator of MS4, CSS, and the wastewater treatment plant (RPWRF), is subject to NPDES regulatory requirements for its discharges of stormwater, treated wastewater, and CSO.
3. Stormwater and CSO discharges and treated wastewater discharges from the City were and are deemed as significant sources of PCB loading to the river, and the City is required to reduce PCBs in these systems in order to meet the state of Washington's and Spokane Tribe's water quality standards (Parsons 2007; Ecology 2011a, 2012). Therefore, the City was and is required to comply with various NPDES permit requirements which are associated with reduction/elimination of PCB loadings from the City to the Spokane River via MS4, CSO, and treated effluent from the RPWRF.
4. The City's stormwater and wastewater/CSO NPDES permit requirements are summarized as follows:
   a. *Stormwater NPDES Permit*: The City's stormwater collection system is made up primarily of three systems:
      - MS4, which conveys only stormwater runoff: Approximately 22 percent, or nearly 10,000 acres, of the City is served by a separated stormwater system. The City has approximately 130 stormwater basins (i.e., 130 stormwater outfalls), including 100 draining to the Spokane River (City of Spokane 2014b).
      - Bioinfiltration swales, drywells, and other facilities that treat and infiltrate stormwater runoff: Drywells have been a commonly used method for stormwater disposal in the City because of the high-permeability soils in many parts of the City. Drywells typically consist of a perforated, pre-cast concrete manhole surrounded by gravel backfill, which allows collected stormwater runoff to infiltrate into the surrounding soil. The City of Spokane owns over 4,300 drywells (City of Spokane 2019b).
      - Evaporation facilities: In certain areas of the City where infiltration of stormwater is not feasible, evaporation facilities have been implemented. These evaporation facilities were constructed during development or redevelopment to manage stormwater because infiltration was not allowed or feasible.

   The City's stormwater discharge has been regulated under a regional phase II MS4 NPDES permit since 2007. Ecology issued the NPDES Eastern Washington Phase II Municipal Stormwater Permit (Stormwater Permit; Permit No. WAR04-6505) to the City in January 2007, with an effective date of February 16, 2007. In 2012, a legislative change directed Ecology to reissue the stormwater permit unchanged for the period of September 1, 2012,

to July 31, 2014. As a result, a second stormwater permit was revised and became effective for the period of August 1, 2014, through July 31, 2019. The third stormwater permit was issued on July 1, 2019 and became effective on August 1, 2019.

The stormwater permit requires the City to develop and implement a Stormwater Management Program Plan (SWMP) addressing six required program elements: (1) public education and outreach, (2) public involvement and participation, (3) illicit discharge detection and elimination, (4) construction site stormwater runoff control, (5) post-construction stormwater management for new and redevelopment, and (6) municipal operations and maintenance (Ecology 2019e).

Section 4 of the stormwater permit requires permittees to not violate any water quality standards, including toxicant standards, sediment criteria, and dilution zone criteria (Ecology 2019e). In 2004, the City wrote and adopted the first Stormwater Management Plan in anticipation of the stormwater permit, because the stormwater permit required a SWMP. Following the issuance of the first stormwater permit in 2007, the City developed and implemented the 2008 SWMP. Since then, the SWMP has been updated; the most recent version was prepared in March 2019.

As part of the SWMP implementation, the City has been taking measures to reduce and eliminate PCB discharges via the City-owned and operated MS4 to the Spokane River. Examples from the current SWMP (City of Spokane 2019a) are as follows:

- PCB-free purchasing ordinance: The City adopted an ordinance requiring City departments to purchase products and packaging that do not contain PCBs unless it is not cost-effective or technically feasible to do so. Cost-effective means that the product does not increase the price by more than 25 percent.
- Union basin PCB sampling/remediation: In 2009, the City sampled stormwater and catch basin sediments throughout the Union basin for PCBs and performed remedial maintenance on the basin after sampling. This sampling/remediation was part of a larger study that also sampled catch basins in other MS4 subbasins throughout the City.
- Cochran and Washington basin PCB investigation: The City's PCB investigation expanded to include the Cochran and Washington stormwater basins. The Cochran stormwater basin is the largest basin in the City (nearly 5,300 acres) and the Washington stormwater basin is much smaller (about 450 acres) but land use is predominantly commercial. PCB samples were collected near the outfalls of both basins to compare concentrations of PCBs in various areas and land uses.
- PCB product sampling grant: The City conducted a PCB sampling/analysis of municipal products, which was funded via a PCB-related Grant of Regional or Statewide Significance from Ecology. The purpose of the PCB sampling/analysis was to define the sources of PCBs to stormwater from products purchased and used by municipalities. Forty-one municipal products that might come into contact with stormwater (e.g., road paint, deicer, dust suppressants) were

sampled and analyzed for PCBs. Almost all products sampled (39 of 41) contained levels of PCB ranging from parts per trillion (ppt) to parts per million (ppm). (City of Spokane 2015a).

The City also has been implementing numerous BMPs to reduce/eliminate stormwater runoff to the river, which has resulted in reduction of PCB load via City's MS4 to the river. The City has implemented bioretention, drywells, soil cells, permeable pavement, and bioinfiltration throughout City's MS4 (Schug 2019). For instance, the City installed four bioretention and permeable pavement BMPs (excluding BMPs for CSOs) in Superior, Mission, and Hollywood Basins between 2015 through 2018, which infiltrate stormwater from total 401 acres. According Michael Baker's modeling, PCB load reduction between 2007 and 2018 due to City's BMP implementation for its MS4 (excluding CSOs) is 92.35 mg/day (72% reduction) from the overall BMPs that the City has implemented to reduce stormwater discharges from the City's MS4 (excluding CSOs). See Trapp's Opinions 5 for further details on the PCB load calculations.

b. *NPDES Permit for the RPWRF and CSOs*: The City's RPWRF is located on a 28-acre site in northwest Spokane along the north bank of the Spokane River. The facility provides wastewater treatment for flows from the City of Spokane, Spokane County (which serves the City of Spokane Valley and Town of Millwood), City of Airway Heights (currently treating and discharging its own flow), and Fairchild Air Force Base. The plant began operation in 1958 as a primary wastewater treatment plant. The treatment capacity was expanded in 1962. Major upgrades occurred from 1975 to 1977 and have been ongoing since 1997 (City of Spokane 2014b). "The facility currently operates as a secondary treatment facility utilizing aeration basins along with chemical precipitation using alum for phosphorus removal. Construction currently is under way to upgrade RPWRF to NLT with tertiary membranes. NLT is expected to be operational to meet the 2021 waste load allocations for the Spokane River Dissolved Oxygen TMDL (DO-TMDL). While phosphorus removal for the DO-TMDL is the driving factor for this project, additional PCB treatment also is expected once NLT is online" (City of Spokane 2019c).

The City's discharges of treated wastewater from the RPWRF as well as CSOs are regulated by the City's NPDES Permit for the RPWRF and CSOs (RPWRF/CSO Permit; Permit No. WA-002447-3; Ecology 2011b). The RPWRF/CSO permit requires monitoring of PCBs at a specified outfall as interim and final effluent limitations for PCBs so that Ecology can establish a performance-based PCB effluent limitation for the following permit cycle (Ecology 2011b).

The RPWRF/CSO permit also requires the City prepare and submit a Toxics Management Plan to Ecology by September 15 annually. The goals of the Toxics Management Plan are to reduce toxicant loadings, including PCBs, to the Spokane River to the maximum extent practicable, realizing statistically significant reductions in the influent concentration of toxicants to the RPWRF, and reduce PCBs in the effluent to the maximum extent practicable to bring the Spokane River into compliance with applicable water quality standards for PCBs. The Toxics Management Plan includes source control and elimination

of PCBs from contaminated soils and sediments, stormwater entering the wastewater collection system, and industrial and commercial sources, by means of eliminating active sources (e.g., older mechanical machinery, older electrical equipment and components, construction material content such as paints and caulking, and commercial materials such as ink and dyes) and changing City procurement practices and ordinances that control and minimize toxics, including preferential use of PCB-free substitutes for those products containing PCBs below the regulated level of 5 ppm.

The RPWRF/CSO permit requires the City to prepare public media educating the public about the difference between products free of PCBs and those labeled non-PCB but which contain PCBs below the Toxic Substances Control Act regulatory threshold of 5 ppm.

As stated in Section 2.4.2 of this document, the City has 20 CSO points as of 2019 (City of Spokane 2017). The City operates its CSO control program within the RPWRF/CSO permit as authorized by the 1972 amendments to the Clean Water Act. In addition to the permit, other regulations apply, including the Washington State Water Pollution Control Law, the USEPA CSO Control Policy (including Nine Minimum Controls) (USEPA 1994), and Washington State Water Quality Standards (WAC 173-201A). The RPWRF/CSO permit specifies a performance standard for controlled CSOs as not more than one discharge event per year, which is evaluated based on a 20-year moving averaging period.

5. WAC 173-201A-420 contains Ecology's Clean Water Act variance provisions. Ecology's general provisions applicable to variances provide that, among other things, "a variance may be considered when the standards are expected to be attained by the end of the variance period or the attainable use cannot be reliably determined." WAC 173-201A-420(1)(a). The City is pursuing an individual discharger variance, which is "a time-limited designated use and parameter-specific change to the standard(s) of the receiving water body for a specific discharger." Pertinent to City's application for an individual discharger variance from PCB HHC, the City evaluated various options/technologies to reduce/eliminate PCBs in discharges from City's RPWRF to the PCB HHC of 7 pg/L and determined no feasible options and technologies are currently available to bring PCB concentrations to 7 pg/L (City of Spokane 2019c). PCB concentrations in the Spokane River upstream and downstream of the RPWRF all exceed the PCB HHC of 7 pg/L, which implies that no dilution credit can be granted to effluent discharge from the RPWRF and PCBs in effluent should be below 7pg/L in order to comply with the HHC.

   Pertinent to this, the City conducted an evaluation of multiple options/technologies as part of the variance application requirements (City of Spokane 2019c):

   a. Agricultural reuse: This option would divert effluent flow from RPWRF to farms in areas north of the City for use in agricultural purposes. This was deemed infeasible due to water rights, property acquisition, exporting pollutants, and logistical issues.
   b. Membrane bioreactors (MBRs): This option was researched as an alternative NLT, but ultimately landed on tertiary treatment. MBRs are over twice as costly as tertiary treatment with similar treatment levels.

c. Reverse osmosis (RO): This option would not feasibly meet the target of 7 pg/L. Additionally, treatment units for RO would not fit within the confines of the current RPWRF area and the City would need to determine a proper method of storage and disposal of the brine waste.
d. Advance oxidation: While research has shown that advanced oxidation can remove up to 99% of the target PCB, this option has only been used in limited applications for specific congener removal with high influent concentrations. The City determined this option was not feasible for such a large-scale facility with limited research on its removal efficacy for lower effluent concentrations.
e. Activated carbon: Similar to advanced oxidation, removal rates of over 99% have been documented but only in cases with high influent concentrations. When tested at lower effluent concentrations, activated carbon was not able to meet the 7 pg/L target.
f. Stream flow augmentation/groundwater recharge/wetlands treatment/urban irrigation: These options were deemed infeasible and they only redirected the PCBs to another waterway which would likely also be subject to the same HHC. Additionally, treatment would likely be required before some of these options, leading to further economic impact.

6. As presented in previous sections, the City has been required to participate in the Task Force because the City was identified as a significant source contributing PCB loading to the Spokane River (Ecology 2011c). The City has been and is actively engaged in this regional effort. Since the Task Force's formation in 2012, the City has conducted PCB sampling and other efforts as part of Task Force functions in order to understand and reduce/eliminate PCB loading from the City to the river. The RPWRF/CSO Permit requires specifically that the City participate in a cooperative effort to create the Task Force and participate in the functions of the Task Force. As stated in Trapp's Opinion 1.2, Ecology requires the direct-to-implementation strategy to address the PCB impairments in the Spokane River via the Task Force. The City, in accordance with its RPWRF/CSO permit, is working with Ecology and others in the Task Force to establish performance-based PCB limits within the time frame of the current NPDES permits (City of Spokane 2014a). The goal of the Task Force was to develop a comprehensive plan to bring the Spokane River into compliance with applicable water quality standards for PCBs. The comprehensive plan was completed in 2016 (LimnoTech 2016).

   The RPWRF/CSO permit specifies functions of the Task Force as follows:

   "(1) Identify data gaps and collect necessary data on PCBs and other toxics on the 2008 year 303(d) list for the Spokane River;
   (2) Further analyze the existing and future data to better characterize the amounts, sources, and locations of PCBs and other toxics on the 2008 year 303(d) list for the Spokane River;
   (3) Prepare recommendations for controlling and reducing the sources of listed toxics in the Spokane River;
   (4) Review proposed Toxic Management Plans, Source Management Plans, and BMPs;
   (5) Monitor and assess the effectiveness of toxic reduction measures;

> (6) Identify a mutually agreeable entity to serve as the clearinghouse for data, reports, minutes, and other information gathered or developed by the Task Force and its members. This information shall be made publicly available by means of a website and other appropriate means." (Ecology 2011b)

The RPWRF/CSO permit also requires that participation in the Task Force should result in measurable progress: "If Ecology determines the Task Force is failing to make measurable progress toward meeting applicable water quality criteria for PCBs, Ecology would be obligated to proceed with development of a TMDL in the Spokane River for PCBs or determine an alternative to ensure water quality standards are met"(Ecology 2011b). The City and other stakeholders signed a Memorandum of Agreement in 2012 that formed the Task Force and defined its operational and organizational concepts.

The Task Force's current focus is to identify unknown sources of PCBs in the river and develop a cleanup plan to comply with water quality standards, e.g., tracking sources of PCBs and developing control methods. Unknown sources include groundwater and dry weather wastewater discharges to the river. The Task Force performed a low-flow synoptic sampling survey to assess contributions from these types of sources. In addition, wet weather sampling was planned to assess relative contributions from stormwater, snowmelt, and other wet weather contributions. The Task Force's future studies include filling the data gaps from other sources such as atmospheric deposition and understanding the potential complications from fish stocking activities. Findings from the studies will assist the City and others in the Task Force with the identification of sources of PCBs and the determination of the most effective control methods. The Task Force will also implement the Comprehensive Plan focusing on efforts of identifying and cleaning up sources of PCBs (City of Spokane 2019a).

7. Prior to the formation of the Task Force, the City began taking actions to address its PCB discharges to the river in response to potential litigation against the City. In December 2009, Spokane Riverkeeper filed a 60-day notice of violation with the City as a precedent to bringing a federal citizen enforcement lawsuit under the Clean Water Act in order to expedite a dramatic reduction in the discharge of PCBs to the Spokane River via the City's MS4. The notice of violation alleges procedural and pollution standard violations of the Clean Water Act as well as the City's stormwater permit (Spokane River Forum 2019). In 2011, the City settled with the Riverkeeper and negotiated the Adaptive Management Plan with the Spokane Riverkeeper as a part of a Consent Decree resolving a Notice of Intent to Sue served on the City pursuant to the Clean Water Act. The Adaptive Management Plan's core goals and principles were based on these organizations' proactive interest in addressing PCBs in the City's stormwater discharges (City of Spokane 2014a).

> "The goal of the adaptive management plan is to reduce PCBs in stormwater through three main strategies: (1) to further analyze and interpret existing PCB data; (2) to identify likely sources of PCBs and prioritize the design and implementation of appropriate remedial actions and BMPs; and (3) to develop and design an adaptive approach for additional data collection and remedial action to further reduce PCBs in the Spokane River" (City of Spokane 2014a). As part of Phase I of the adaptive management plan, the

City conducted PCB sampling and remedial maintenance at priority areas of investigation including the Union stormwater basin and the CSO 34 basin located in the heavy industrial zone as well as PCB source investigations. The City is designing infiltration BMPs in the Union Basin, which will treat and infiltration stormwater, capturing PCBs in the treatment media and allowing the stormwater to infiltrate to the subsurface. The outfall will be disconnected, preventing untreated stormwater from entering the river." (City of Spokane 2014a)

8. The City developed the Integrated Clean Water Plan following USEPA guidance, in cooperation with Ecology. The City implemented this planning process to integrate the City's clean water investments, including projects for stormwater, CSOs, and the tertiary membrane treatment of municipal wastewater, called next level of treatment (NLT, at the City's RPWRF, to comprehensively maximize the benefits provided by the City's clean water investments. Implementation of this Integrated Clean Water Plan will prevent a significant amount of PCBs from entering the Spokane River (City of Spokane 2014a). "An analysis of PCB removal demonstrates the value of the City's Integrated Plan. Mandated projects would deliver about 17 grams of PCB removal annually for the River. When the voluntary components of the City's Integrated Plan—running the membrane filtration technology at the wastewater plant during the non-critical season and addressing the stormwater runoff from the Cochran Basin—the results reach nearly 30 grams of PCB removal annually… The Integrated Plan also includes an adaptive management approach. The approach would remove stormwater from combined and separated stormwater piping as part of street and other public works projects. The City has budgeted for a $5 million annual investment for the utility portion of such projects. This work would capture PCBs on site, although the City hasn't quantified the PCB reduction benefit of this approach yet." (City of Spokane 2019d)

Trapp's Opinion 3 – Discharges of stormwater runoff via City-owned and -operated MS4 are a significant source of PCBs to the Spokane River and contribute to the impairments to the beneficial uses in the river.

1. PCB loading from the City-owned and -operated MS4 is deemed as a significant source to PCBs in the Spokane River. A target instream PCB load in order to meet the HHC of 7 pg/L is 114 mg/day at Ninemile monitoring location based USGS flow data[6]. Of the target instream load, PCB load estimated from City's MS4 (excluding CSOs) by Michael Baker are 36.6 mg/day. Derivation of calculations is further discussed in Trapp's Opinion 5. The estimated PCB loads from City's MS4 (excluding CSOs) of 36.6 mg/day is almost the one-third (32%) of the target instream loads.
2. PCBs are present in stormwater discharges from City-owned and -operated MS4 to the river.
    a. Stormwater data collected from City's MS4 and presented in Tables 23 through 25 in Ecology (2011a) demonstrate that PCBs are present in stormwater from the City and PCB concentrations in stormwater from the City's MS4 far exceed the HHC of 7 pg/L. For

[6] Ninemile monitoring location – Arithmetic mean of 2003-2018 flow data from USGS gages 12422500 + 12424000

instance, PCB concentration was as high as 106,802 pg/L at Union Basin of which land use is 100% industrial (Ecology 2011a).

b. My review of data received from the City via Baron & Budd, P.C (hereafter referred to as Spokane PCB database v26), which include more recent stormwater data, indicate that PCB concentrations in stormwater from City's MS4s remain considerably high. 2019 data show that PCBs in stormwater from Cochran Basin range from 10,000 pg/L to 18,000 pg/L. Land uses in Cochran Bain consist of open (4%), commercial (52%), industrial (5%), and residential (39 %). The land uses in Cochran Basin is similar to City's overall land uses, which consist of open (7%), commercial (51%), industrial (5%), and residential (37%): Figure 5. Due to this land use similarity, it is expected that overall PCB concentrations in stormwater discharges from the City are likely similar to PCB concentrations from Cochran Basin.

3. City's MS4 contributes significantly to PCBs in the river, which cause the impairments in the beneficial uses of the river as presented in Trapp's Opinion 1. Without reduction/elimination of PCB load from the City's MS4, the impairments cannot be fully addressed and the beneficial uses cannot be completely restored.

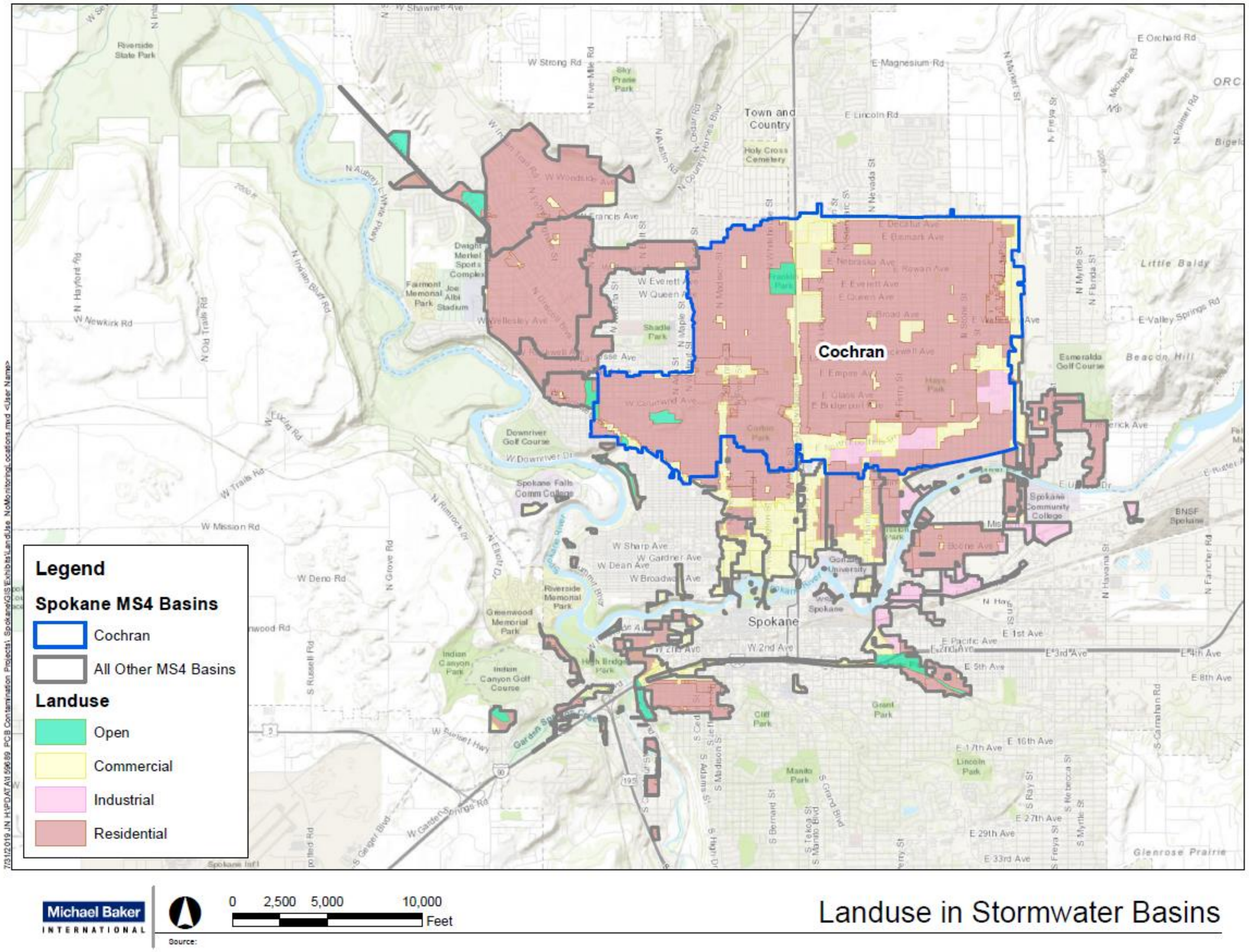

FIGURE 5. LAND USES IN COCHRAN BASIN AND THE CITY OF SPOKANE (CITY OF SPOKANE 2019E).

Trapp's Opinion 4 – As the owner and operator of the MS4, the City is and will continue being required to eliminate stormwater discharges from City-owned and -operated MS4 to the river in order to comply with the HHC for PCBs.

1. As the owner and operator of the MS4, the City is and will continue to be required to mitigate its contribution of PCBs via the City-owned and -operated MS4 to the river in order to achieve compliance. As discussed in Opinion 3, the City's contribution of PCBs from its MS4 (excluding CSOs) to the river is significant and the reduction/elimination of City's PCB loading from the MS4 is critical to achieve the HHC in the river and restore beneficial uses of the river.
2. My review of publicly available data indicates that PCB concentrations in receiving water (i.e., instream PCB concentrations in the Spokane River) already exceed the PCB HHC of 7 pg/L.
    a. Various types of PCB data were collected as part of Ecology's efforts to assess sources for PCBs in the Spokane River (Ecology 2011a), which include PCB concentrations in the section of the river where the City discharges (approximately between Upriver Dam RM 80.2 and Ninemile Dam RM 58.1). Dissolved PCB concentrations[7], which were measured via semipermeable membrane devices (SPMDs), and PCB concentrations in whole river water samples exceeded the PCB HHC of 7 pg/L. For instance, dissolved PCB concentrations in the river at Monroe Street range from 76 pg/L to 231 pg/L and total PCB concentrations in the river at Riverside State Park is 130 pg/L (Ecology 2011a).
    b. Data, which the Task Force collected at Ninemile Dam River monitoring location (SR-1) between 2014 and 2016, show that instream PCB concentrations range from 62 pg/L to 187 pg/L with arithmetic mean of 144 pg/L and geometric mean of 132 pg/L (LimnoTech 2016), which exceed the PCB HHC of 7 pg/L.
    c. Data, which the Task Force collected for a dry weather mass balance assessment in August 2018, demonstrate that instream PCB concentrations during the dry weather also exceed the PCB HHC of 7 pg/L: PCB concentrations, which were measured in the river between downriver of Upriver Dam and Below Ninemile Dam, range from 63.1 pg/L to 129.1 pg/L (LimnoTech 2019).
3. Due to the fact that PCBs are already present in the receiving water at the levels exceeding the HHC, the City has to either reduce PCB concentrations in stormwater from all of the City-owned and -operated MS4 outfalls to the PCB HHC of 7pg/L before discharging to the river or eliminate all discharges of stormwater from all of City-owned and -operated MS4 outfalls to the river.
4. Because no feasible technology is available to treat the entire stormwater discharges from the City's MS4 to the level of the PCB HHC of 7 pg/L, the City has no option other than eliminate the discharges of stormwater by capturing and infiltrating them. The City examined the available treatment technology for its RPWRF and concluded the lack of feasible options as part of its application requirements for an individual discharger variance from the PCB HHC (City of Spokane 2019c). Further details are as follows.

[7] PCB concentration in a water sample is a sum of two phases: dissolved and particulate phases. Therefore, actual PCB concentrations should be higher than dissolved PCB concentrations alone due to particular concentrations which were not measured in SPMDs.

a. As presented in Trapp's Opinion 2.5, pertinent to City's application for an individual discharger variance from the PCB HHC, the City evaluated various options/technologies to reduce/eliminate PCBs in discharges from City's RPWRF to the PCB HHC of 7 pg/L and determined no feasible options and technologies are currently available to bring PCB concentrations to 7pg/L (City of Spokane 2019c).
b. The City evaluated membrane bioreactors, reverse osmosis, advanced oxidation, activated carbon, agricultural reuse, and steam flow augmentation/groundwater recharge/wetlands treatment/urban irrigation. None are logistically nor economically feasible to bring down PCB concentrations to the 7 pg/L limit.
c. Furthermore, even if PCBs in water are treated and reduced to the 7 pg/L limit, it is nearly impossible to measure PCBs concentrations so low using US EPA standard method 1668C, which is typically used for PCB analysis. Only 5 of 81 blank samples (from lab-grade purified water) resulted in values below the 7 pg/L limit (City of Spokane 2019c).

This lack of feasible options for the treatment technology also applies to City's MS4. Because no feasible treatment options exist, the City must capture and infiltrate stormwater to prevent the discharge of PCBs to the Spokane River.

Trapp's Opinion 5 –To fully eliminate the discharge of PCBs from the City's MS4, as is required to comply with the HHC and corresponding regulations, the City of Spokane will incur costs of $288,867,330. In addition, the City will incur $1,626,000 in costs associated with 30-year monitoring.

1. As stated in Trapp's Opinion 3, the City-owned and -operated MS4 is a major contributor of PCB load to the Spokane River. Trapp's Opinion 4 presents the City's requirements, in the light of the receiving waters exceeding the current PCB HHC of 7 pg/L, to treat stormwater discharges from the City-owned and -operated MS4 to the PCB HHC or eliminate the discharges to meet the regulatory compliance. Because no technology is available to treat stormwater discharges to the required level, the City must use infiltration as a mitigation measure to reduce MS4-PCB discharges to the Spokane River. Note that this does not include CSOs, which is presented in Bowdan's opinions.
2. The City started designing and constructing BMPs to target PCBs following Ecology's Spokane River PCB TMDL Stormwater Loading Analysis (Parsons 2007) and City's Integrated Clean Water Plan (2014a). Source control efforts such as street sweeping and infiltration BMPs including dry wells and bioretention were determined to be the most cost-effective treatment methodology. An ongoing City-wide mitigation effort to employ regional and localized BMPs has included the installation and retrofitting of hundreds of dry wells (City of Spokane 2019f). These efforts constitute a significant reduction in the City stormwater runoff and thus PCB loads delivered to the Spokane River.
3. PCB loads from the City-owned and -operated MS4 were calculated.
    a. A detailed analysis using watershed modeling was conducted as part of this expert report to understand and quantify the benefits of the BMP deployment efforts undertaken. This modeling effort is also used as a tool to estimate additional actions required for the City

take to achieve regulatory compliance related to the removal of PCBs from the MS4 system. The modeling analysis included the following;

i. baseline condition representing the beginning of the City's mitigation efforts to reduce PCB discharge based on available data prior to Ecology's Spokane River PCB TMDL Stormwater Loading Analysis (Parsons 2007),
ii. a current condition representing the net effects of MS4 improvements made to-date; and
iii. estimated required actions the City must undertake on the MS4 system to meet the consent decree obligations.

b. This analysis consisted of the following main components:
   i. Define the City-owned and -operated MS4 to be examined as part of the analysis.
   ii. Research existing stormwater data to determine representative PCB concentrations in stormwater discharges.
   iii. Conduct watershed-based hydrologic modeling of the MS4 to calculate annual discharge volume from stormwater basins. This will be used to establish a baseline condition and evaluate current and proposed future conditions.
   iv. Determine the effects of the mitigation actions that the City has taken to date to remove PCBs from the City-owned and -operated MS4 to the river to determine the current condition.
   v. Establish proposed future conditions and additional actions required that the City must take to reduce PCB loads from the City-owned and -operated MS4 to the river to achieve regulatory compliance.
   vi. Summarize the net reductions of PCB load in stormwater discharges from the City-owned and -operated MS4 to the river as a result of the current and future actions of the City to remove PCBs from the MS4.

c. *Stormwater basins in the City*: The City-owned and -operated MS4 contains approximately 130 stormwater basins. The sizes of these basins vary greatly and thus a prioritized group of stormwater basins was used to estimate PCB loads for the entire City. Twelve of the stormwater basins were selected/prioritized for analysis because they account for approximately 85% of the total MS4 areas in the City; Cochran, Greene, Kiernan, Hollywood, Howard, Lincoln, Mission, Rifle Club, Riverton, Superior, Washington, and Union Basins. This approach is consistent with earlier analysis presented in Ecology's Spokane River PCB TMDL Stormwater Loading Analysis (Parsons 2007), which used the largest stormwater basins in its estimates. This methodology is considered valid as these 12 stormwater basins contain the expected highest PCB loading land use areas (e.g., Union Basin as stated in Trapp's Opinion 3.2) as well as represent the vast majority of the City-owned and -operated MS4. The additional 118 stormwater basins delineated in the City' GIS database were not examined in this analysis for loading and cost calculations on an individual basis because their contributions are relatively minimal in comparison to the individual or combined values of the larger basins which constitute the majority of the City-owned and -operated MS4.

d. *Stormwater PCB data from the City*: Historical and ongoing PCB data collected within the City's MS4 have been compiled in a database of available environmental data pertaining to PCBs within the Spokane River system (i.e., Spokane PCB database v26).

   i. The Spokane PCB database v26 was queried for all stormwater related total PCB congener concentration data. The results of this search include data, which fall into four categories:

      1) Stormwater PCB data from ten of the City's MS4 outfalls to the Spokane River in 2004 and presented in Ecology's Spokane River PCB TMDL Stormwater Loading Analysis (Parsons 2007)
      2) Stormwater PCB data collected subsequent to Parsons (2007) in a limited number of stormwater basins; i.e., Cochran, Washington, and Union Basins. These stormwater PCB data were used in the City's 2014 Integrated Clean Water Plan for MS4-PCB load estimates (City of Spokane 2014a)
      3) Stormwater PCB data from the Cochran, Washington, and Union Basins collected after the development of the 2014 Integrated Clean Water Plan estimates (City of Spokane 2014a)
      4) Site specific data including special studies such as BMP performance studies.

   ii. Data from 2007 to 2018 were determined to be the most representative and accurate data to reflect current conditions for this analysis. The data from this period are also used for past conditions in this analysis due to their more recent and theoretically more representative nature, based on the large number of data available from the data set and the composite collection methodology (representing an event mean PCB concentration, which is a mean PCB concentration during a storm/sampling event).

   iii. For PCB load calculations, concentrations of all 209 PCB congeners were summed as total PCB concentrations. PCB concentrations reported as less than detection limits were assigned with values equal to the detection limits. Table 4 presents the number of data available for each stormwater basin as well as descriptive statistics including the minimum, maximum, and arithmetical mean of the respective data. These arithmetical means are used for all subsequent loading calculations.

TABLE 4. TOTAL PCB CONCENTRATIONS IN STORMWATER FOR COCHRAN, UNION, AND WASHINGTON BASINS

Stormwater Basin	Number of Data	Minimum	Arithmetical Mean	Maximum	Units
Cochran	36	920	11,290	53,470	pg/L
Union	22	7,310	91,780	461,100	pg/L
Washington	11	4,180	8,850	14,260	pg/L

   iv. Stormwater PCB data from the selected period (2007-2018) are available for Cochran, Union, and Washington basins. Stormwater PCB data does not exist for

this period for the remaining nine stormwater basins included in the modeling effort. For those basins, I assigned one of the three basin's arithmetic mean concentration as an event mean concentration. GIS land use data available from the City were examined in order to determine which of the three stormwater basins with stormwater data available most closely represent land uses in the these remaining nine basins. The land use breakdowns for each basin are shown in Table 5 as well as sources of event-mean PCB concentrations for the nine basins with no PCB data available.

TABLE 5. LAND USE BREAKDOWN FOR 12 STORMWATER BASINS

Stormwater Basin	Percent Open	Percent Residential	Percent Commercial	Percent Industrial	Basin Event Mean PCB Concentration Used
Cochran	4.2	38.6	52.2	5.0	Cochran
Union	0	0	0	100	Union
Washington	8.3	18.3	73.4	0	Washington
Riverton	31.8	32.2	36.0	0	Cochran
Superior	9.8	42.9	47.3	0	Cochran
Mission	15.6	59.2	17.3	7.9	Cochran
Greene	0	25.5	56.0	18.5	Cochran
Howard	11.3	17.2	71.5	0	Washington
Lincoln	16.7	10.6	72.7	0	Washington
Hollywood	26.3	42.5	31.1	0	Cochran
Rifle Club	10.1	67.0	22.9	0	Cochran
Kiernan	42.5	22.6	34.9	0	Cochran

e. *Stormwater discharge volume calculations*: Stormwater discharge is a function of precipitation, land use/percent imperviousness, soil characteristics, and drainage area. There are several different commonly used computer programs that are capable of calculating discharge. For this analysis, WinSLAMM was selected to calculate the average annual discharge volume. The WinSLAMM Source Loading and Management Model was developed starting in the mid-1970's as part of early US EPA street cleaning and receiving water projects. The 1983 Nationwide Urban Runoff Program provided a large data set for the model. Subsequent updates and model improvements based on research have yielded WinSLAMM 10.3.4. Although the software has vast pollutant modeling capabilities, given the presence of direct PCB sampling results, the software was primarily used for long-term hydrologic modeling. The software is commonly used in the industry across the country for watershed modeling, urban stormwater runoff modeling, and urban pollutant transport. Files associated with the WinSLAMM modeling work are provided in Appendix D

f. *PCB Loads under existing conditions:* Baseline and current conditions were modeled as existing conditions.

i. Baseline condition - Parsons (2007) calculated average annual discharge based on the "simple method" which by its nature results in a conservative higher-end result. In the simple method, the annual runoff volume is calculated based on annual rainfall, a runoff fraction, and a runoff coefficient. The runoff coefficient is a function of the percentage of impervious cover within the watershed (i.e., stormwater basin). An average annual precipitation depth of 18 inches was used for the Spokane region consistent with the Parsons (2007) study (Table 6). The year 2007 is also used in this model as a baseline condition as it represents the beginning of City efforts to prevent PCBs from reaching the river via the City-owned and -operated MS4 and provides opportunity to compare to and validate the results from Parsons (2007). 51 Years of historical precipitation data from the Spokane International Airport were used for precipitation input for the WinSLAAM modeling. This precipitation, in conjunction with the runoff coefficients and drainage areas of 12 stormwater basins, resulted in 51-year total stormwater runoff discharge (Table 6). Then the total discharge was divided by the 51-year model duration to calculate the average annual discharge, which was used for the 2007 baseline condition. Results for the baseline condition (2007) are in good agreement with the reported values from Parsons (2007) for the 12 major basins (Table 6).

TABLE 6. AVERAGE ANNUAL STORMWATER DISCHARGES

Stormwater Basin	Ecology's Spokane River PCB Loading Analysis (Parsons 2007) (CF)	Baseline Condition (2007) (CF)	Current Condition (2018) (CF)
Cochran	90,060,591	83,090,379	24,295,432
Union	2,178,993	2,013,605	649,563
Washington	11,630,208	10,530,612	3,325,559
Riverton	3,355,382	3,055,394	973,761
Superior	6,710,764	6,132,167	1,252,089
Mission	962,500	884,937	52,439
Greene	761,979	689,018	222,935
Howard	1,390,278	1,290,573	407,580
Lincoln	2,192,361	2,015,549	657,920
Hollywood	25,345,833	10,592,809	1,906,511
Rifle Club		9,640,428	2,699,708
Kiernan		5,914,480	1,656,171

CF, cubic feet

1. In Parsons (2007), the Hollywood, Rifle Club, and Kiernan basins were also cumulatively referred to as the Hwy 291 basin.

ii. Current condition - Discharge volumes for the current condition were modeled to reflect City's actions in each stormwater basin to remove stormwater runoff discharges and PCBs from the City-owned and -operated MS4, and to account for discharge data and precipitation data were available from 2007 to 2014. Based on the extrapolated rainfall/runoff relationship, a City-specific correlation value based on City's imperviousness was developed to calculate stormwater runoff discharge. A calculation spreadsheet is presented as Appendix E. The use of measured discharge and precipitation data in the existing condition analysis, as opposed to the simple method used in the baseline condition, accounts for a part of the volume reduction shown in Table 6. Because City's MS4 discharge data after 2014 are currently unavailable, the WinSLAMM model was used to estimate stormwater runoff discharge volume accounting for BMPs installed since 2014. BMPs installed since 2014 were assumed to achieve full infiltration of the stormwater runoff from the entire BMP drainage area. This approach gives full credit of PCB removal as it assumes full capture/infiltration and thus no stormwater discharges occur from areas draining to the BMPs: consequently, no PCB load is created from the BMP drainage areas. The results of the current condition (2018) are shown in Table 6. City MS4 actions to date, in combination with the measured discharge and precipitation date have resulted in significantly lower average annual stormwater discharges in the current condition (2018) as compared to results from Parsons (2007) or our 2007 baseline condition from the WinSLAMM modeling (Table 6).

PCB load reduction between the 2007 baseline and current conditions – The reductions in stormwater discharges reported in the current condition are also reflected in the calculated reduction in PCB loads being delivered to the river. Where daily PCB loads have been reduced between 68 percent – 94 percent (Table 7). The daily PCB loads for each of the 12 stormwater basins were calculated as a function of an average event mean PCB concentration (Tables 4 and 5) and annual average stormwater discharges (Table 6). The PCB-load reductions reported between the 2007 baseline and the 2018 current conditions demonstrate that the City's mitigation efforts (structural/non-structural BMPs and source controls) to reduce PCBs from the City-owned and -operated MS4 to the river are significant and this approach has been successful. However, the City's mitigation efforts taken to date, which have focused on the highest potential and easiest access activities, are not sufficient to meet the PCB HHC of 7pg/L because only zero stormwater discharges from the City-owned and -operated MS4 could guarantee the compliance with the PCB HHC as stated in Trapp's Opinion 4. The City must take additional actions consisting of the installation BMPs to remove PCBs in stormwater or reduce/eliminate stormwater discharges containing PCBs from the City-owned and -operated MS4 to the river.

TABLE 7. AVERAGE DAILY PCB LOADS

Stormwater Basin	Baseline Condition (2007) (mg/day)	Current Condition (2018) (mg/day)
Cochran	72.78	21.28
Union	14.34	4.63
Washington	7.23	2.28
Riverton	2.68	0.85
Superior	5.37	1.10
Mission	0.78	0.05
Greene	0.60	0.20
Howard	0.89	0.28
Lincoln	1.38	0.45
Hollywood	9.28	1.67
Rifle Club	8.44	2.36
Kiernan	5.18	1.45
TOTAL	***128.94***	***36.60***

In addition to the baseline and the current conditions, average annual stormwater discharges and average daily PCB loads were also estimated for a 2012 condition to support Dilks (2019). The stormwater discharge volumes for the 2012 condition were calculated based on 2012 flow and precipitation monitoring in the Cochran basin. PCB loads were determined based on measured concentrations from Database v26.

g. *PCB loads under proposed future conditions for compliance*: As stated in Trapp's Opinion 4, the most feasible option for the City to achieve PCB load reductions is to capture/infiltrate stormwater runoff by installing infiltration BMPs. BMPs that provide infiltration can effectively prevent stormwater runoff from entering to the City-owned and -operated MS4 and consequently discharging to the river. Therefore, the BMPs can prevent the City's MS4 from discharging PCBs to the river. [8]

The WinSLAMM model was used to calculate the additional stormwater discharge volume, which is required to be captured/infiltrated for the compliance as the proposed future conditions. Three proposed scenarios were analyzed representing different compliance conditions:

i. Compliance scenario 1: Full infiltration of all stormwater runoff from the City (12 stormwater basins) as derived from the 51-year precipitation data. This scenario sizes BMPs to infiltrate all stormwater runoff volume produced based on the full precipitation history under the current condition (2018) scenario.

[8] This capture/infiltration BMPs differ from traditional filtration-based structural BMPs (e.g., lined biofiltration and vegetated filter strips) or non-structural BMPs (e.g., street sweeping), which are not capable of reducing PCBs to the required level (BASMAA 2017; San Francisco Estuary Institute 2010).

ii. Compliance scenario 2: Full infiltration of runoff from a single 1" precipitation event. This scenario sizes BMPs to infiltrate a single 1" precipitation event. This event was selected since it represents Spokane County's BMP design standards for bio-infiltration swales (Spokane County et al. 2008).

iii. Compliance scenario 3: Full infiltration of runoff from a single 10-year precipitation event. This scenario sizes BMPs to infiltrate a single 10-year precipitation event (1.8 inches). This standard represents City's storm drain design standard (City of Spokane 2007). The runoff produced under these conditions reflect the standards to which the storm drain infrastructure which conveys stormwater is designed to and the which runoff is conveyed into the BMPs.

Note that only the compliance scenario 1 will allow the City to fully comply with the HHC of 7 pg/L due to the reasons presented in Trapp's opinion 4; i.e., due to the fact that PCBs are already present in the receiving water at the levels exceeding the HHC and no feasible technology is available to treat the entire stormwater discharges from the City's MS4 to the level of the PCB HHC of 7 pg/L, the City has to eliminate all discharges of stormwater from all of City-owned and -operated MS4 outfalls to the river. Under the compliance scenarios 2 and 3, the City will still discharge PCBs from its MS4 at a level exceeding the HHC of 7 pg/L to the river for a storm larger than scenarios' design storm sizes and the City will not be in full compliance with the requirements. Despite this, the compliance scenarios 2 and 3 were also evaluated because, based on my own professional experience, a regulatory agency such as Ecology may consider an option of alternative compliance such as the scenarios 2 and 3 when the compliance with the stringent requirement is technically challenging and requires tremendous resources.

Based on the 51-year precipitation data, no stormwater runoff and thus no PCBs would be discharged from the City-owned and -operated MS4 to the river under the full infiltration scenario 1. However, under the other two scenarios stormwater runoff in excess of the design event will be still discharged from the City's MS4 during larger events. WinSLAMM model results for average annual discharge volumes for the other two scenarios are presented in Table 8.

TABLE 8. AVERAGE ANNUAL STORMWATER DISCHARGES

Stormwater Basin	Baseline Condition (2007) (CF)	Current Condition (2018) (CF)	Future Conditions		
			Compliance Scenario 1 Full Infiltration (CF)	Compliance Scenario 2 1" Precipitation Event (CF)	Compliance Scenario 3 10-year Precipitation Event (CF)
Cochran	83,090,379	24,295,432	0	30,340	405
Union	2,013,605	649,563	0	387	2
Washington	10,530,612	3,325,559	0	2,874	11
Riverton	3,055,394	973,761	0	1,154	15
Superior	6,132,167	1,252,089	0	1,492	18
Mission	884,937	52,439	0	52	<1
Greene	689,018	222,935	0	247	3
Howard	1,290,573	407,580	0	453	5
Lincoln	2,015,549	657,920	0	738	9
Hollywood	10,592,809	1,906,511	0	1,512	6
Rifle Club	9,640,428	2,699,708	0	2,324	9
Kiernan	5,914,480	1,656,171	0	1,407	5

CF, cubic feet

4. The resulting annual PCB loads based on the compliance scenario discharge volumes are summarized in Table 9.

TABLE 9. AVERAGE ANNUAL PCB LOADS

Stormwater Basin	Baseline Condition (2007) (mg)	Current Condition (2018) (mg)	Future Conditions		
			Compliance Scenario 1 Full Infiltration (mg)	Compliance Scenario 2 1" Precipitation Event (mg)	Compliance Scenario 3 10-year Precipitation Event (mg)
Cochran	26,560	7,767	0	9.70	0.130
Union	5,230	1,688	0	1.01	0.004
Washington	2,640	833	0	0.72	0.003
Riverton	980	311	0	0.37	0.005
Superior	1,960	400	0	0.48	0.006
Mission	280	17	0	0.02	0.0001
Greene	220	71	0	0.08	0.001
Howard	320	102	0	0.11	0.001
Lincoln	510	165	0	0.19	0.002
Hollywood	3,390	610	0	0.48	0.002
Rifle Club	3,080	863	0	0.74	0.003
Kiernan	1,890	529	0	0.45	0.002

5. As presented Trapp's Opinion 5.1 through 5.4, the City is required to conduct ongoing mitigation efforts, to meet MS4 regulatory PCB water quality requirements, which necessitate the installation of a significant number of additional infiltration BMPs to prevent PCBs from entering the river via the City-owned and -operated MS4. The cost to install these BMPs has been calculated based on the National Cooperative Highway Research Program (NCHRP) Report 792 *Long-Term Performance and Life-Cycle Costs of Stormwater Best Management Practices* BMP Evaluation Tool V.1.0 (Taylor et al. 2014). This tool calculates a whole life cost based on upfront capital cost, long-term operations and maintenance, and easement/property acquisition. Capital costs include not only labor and materials, but also associated costs such as design, topographic survey, and geotechnical evaluation. All costs are calibrated to the City using a location adjustment factor of 98.8[9].
6. Each future compliance scenario analyzed in Trapp's Opinion 5 yielded a total BMP infiltration volume (hereafter referred to as BMP volume) necessary to manage stormwater runoff in each of the 12 stormwater basins. It is unrealistic to assume that the total required infiltration volume in each stormwater basin could be achieved using one single BMP without acquisition of a large amount of private property at the discharge location to the river. As such, the capital cost analysis is based on the following assumptions about typical bioretention BMPs which could be located/distributed throughout the watershed. This distributed approach is more realistic and conservative than assuming one single large BMP. Thus, a standard BMP configuration is used to determine an extrapolated cost for each watershed based on the calculated BMP infiltration volume for the compliance scenarios presented in Trapp's Opinion 5: a summary calculation spreadsheet is presented in Appendix F and BMP infiltration volumes were calculated using the WinSLAMM modeling of which files are available in Appendix D.
7. A conceptual standard bioretention BMP based on City's BMP standards has been designed to meet the modeling needs. The resulting BMP has the following design attributes:
   - Each BMP would require an average of 80 total lineal feet of storm drain to divert flow into and out of the BMP. This is equivalent to approximately twice the half width of a typical street in the City.
   - Each BMP would have a single inflow and outflow structure.
   - The BMP surface area is 2,000 square feet which equates to either 4,000 cubic feet or 6,000 cubic feet of stormwater storage (depending on soil type).
   - Surface ponding depth = one foot for Type C soil and two feet for Type B soil
   - Mulch layer depth = three inches
   - Engineered soil media depth = 18 inches
   - Gravel reservoir depth = 12 inches
   - Freeboard above ponding depth = six inches

   Since the surface ponding depth varies based on soil type, the associated capital cost also varies. The total unit capital costs are $26.21 per cubic foot of storage for BMPs in Type C soil and $18.21 for Type B soil. Calculation spreadsheets are presented in Appendix G.

[9] 100 is considered the nation-wide average.

8. Since a non-location-specific distributed approach is being used, a conservative methodology of the calculation of land access for BMP construction and maintenance has been taken for this analysis. Based on the City's real estate study (DeLacy Consulting LLC 2015) the lowest land acquisition cost, and thus most conservative way to estimate access to land to build these BMPs would be the acquiring of easements. Based on this 2015 study a cost of $5.68 per square foot is used for land.
9. Operations and maintenance costs were calculated with an assumed medium maintenance frequency over a 30-year maintenance life per the guidance in the NCHRP Report 792 (Taylor et al. 2014). This included, but was not limited to, routine maintenance activities (inspection, vegetation management, and trash removal) and infrequent maintenance activities (corrective maintenance and sediment management). Long-term inflation was neglected when calculating whole life maintenance cost. The resulting 30-year operation and maintenance cost for the standard modeled BMP is $72,600.
10. A combined cost on a per-unit basis was calculated based on the three principle cost components. The final cost estimates, which were used to calculate the total cost to implement the BMP plan for each watershed, were determined to be $47.20 per cubic foot of BMP infiltration volume for Type C soil and $32.20 for Type B soil.
11. Total cost is calculated based on the combined unit cost and the required BMP infiltration volume as calculated in the three compliance scenarios from Trapp's Opinion 5. Results for each modeled basin are presented in Table 10.

Table 10. Whole Life Cost for Future Compliance Scenarios

Stormwater Basin	Future Compliance Scenario 1	Future Compliance Scenario 2	Future Compliance Scenario 3
Superior	$35,398,688	$16,519,388	$32,094,810
Riverton	$17,935,335	$8,023,703	$16,047,405
Mission	$4,814,222	$2,171,120	$4,436,636
Greene	$3,587,067	$1,415,948	$3,209,481
Howard	$3,775,860	$1,793,534	$3,492,671
Lincoln	$3,681,464	$1,699,137	$3,398,274
Hollywood	$14,490,900	$6,762,420	$13,911,264
Rifle Club	$12,317,265	$5,796,360	$11,592,720
Kiernan	$8,887,752	$4,154,058	$8,501,328
Union	$5,097,411	$2,265,516	$4,247,843
Washington	$17,463,353	$11,327,580	$21,239,213
Cochran	$161,418,015	$75,045,218	$147,258,540
TOTAL	***$288,867,330***	***$136,973,979***	***$269,430,183***

As presented in Trapp's opinion 5.3.g, only the scenario 1 will bring the City to the full compliance with the PCB HHC of 7 pg/L by fully infiltrating all stormwater runoff from the City's 12 stormwater basins and resulting no stormwater discharges from these 12 stormwater basins. The scenarios 2 and 3 were also evaluated as potential compliance alternatives, which regulatory agencies may consider.

12. In addition to the costs of the implementation of the BMPs required to meet the compliance scenarios, the City will incur a cost of $1,626,000 associated with PCB monitoring for 30 years. The monitoring will include receiving water monitoring at a section of the Spokane River where the City discharges via City's MS4 and stormwater basin monitoring at the 12 stormwater basins used for modeling the compliance scenarios.
    a. The City conducted in receiving water monitoring for PCBs to comply with the MS4 NPDES Permit, which required the City to participate in the Task Force. As part of Task Force's study, the City monitored PCB concentrations at two receiving water monitoring locations within the section of the river where the City discharges via City's MS4 (LimnoTech 2016). The City will continue being required to monitor the receiving water at these two locations (at the minimum) in order to demonstrate City's implementation of the BMPs will result in the reduction of PCBs in the river and to examine whether any sources/pathways other than City's MS4 will be required to mitigated to achieve PCB reduction in the river.
    b. The City will be required to conduct a monitoring of City's stormwater basins for the planning and implementation of the BMPs under the compliance scenarios. The monitoring will be performed in phases. During the first phase (Years 1 through 5), the City will conduct sampling every four months in sub-catchment areas throughout the 12 modeled stormwater basins to determine whether any of sub-catchment areas will need to be prioritized in the BMP implementation (e.g., a sub-catchment of higher PCB loading) and/or identify any new source(s) of PCBs in the individual stormwater basins, which may need additional mitigation efforts (e.g., soil excavation/remediation or runoff control at a source site by a site owner or operator). During the second phase (Years 6 through 10), the City will conduct one wet- and dry-weather sampling at the 12 stormwater basins to continue monitoring the progress of the BMP implementation and PCB loads from the stormwater basins. In the third phase (Years 11 through 30), the City will conduct annual sampling at the 12 stormwater basins to monitor the long-term performance of the BMPs implemented.
    c. Breakdown costs for the monitoring in these three phases are presented in Table 11.

TABLE 11. 30-YEAR COSTS FOR THE PCB RECEIVING WATER AND STORMWATER BASINS MONITORING

	Monitoring Period	No. of Location	No. of Sample	No. of Event	Total No. of Samples per Year	Analytical Cost per Sample[A]	Analytical Cost per Year	Consultant Cost per Year[B]	Total Cost per Year	Total Cost Per Monitoring Period
Receiving Water Monitoring	Years 1-30	2[C]	2	2	8	$900	$7,200	$10,000	$17,200	$516,000
Stormwater Basin Monitoring	Phase 1 Years 1-5	12[D]	3	3	108	$900	$97,200	$10,000	$107,200	$536,000
	Phase 2 Years 6-10	12[D]	1	2	24	$900	$21,600	$10,000	$31,600	$158,000
	Phase 3 Years 11-30	12[D]	1	1	12	$900	$10,800	$10,000	$20,800	$416,000
									Total 30 Year Cost	$1,626,000

[A] Analytical cost for PCB 209 congener analysis via US EPA 1668 as of September 2019
[B] Includes costs to design and conduct sampling and report sampling results
[C] Two monitoring locations sampled in 2016 Task Force study (LimnoTech 2016)
[D] 12 modeled stormwater basins for the BMP implementation in Trapp's Opinions 5 and 6

Bowdan's Opinion 1 – Discharges of untreated CSOs via City-owned and -operated CSS and treated effluent from the RPWRF are significant sources of PCBs to the Spokane River and contribute to the impairments to the beneficial uses in the river.

1. PCB loadings from the City-owned and -operated CSS and RPWRF are deemed as significant sources to PCBs in the Spokane River.
   a. Trapp's Opinion 3.1 indicated that a target instream PCB load of 114 mg/day at Ninemile monitoring location is required in order to meet the HHC of 7 pg/L. Of the target instream load, PCB load estimated from City's CSOs (excluding MS4) by Michael Baker is approximately 36.0 mg/day for the period 2003-2007 (Bowdan Appendix H-2). Data source is discussed in Bowdan's Opinion 1.2.c., and derivation of calculations are discussed in Bowdan's Opinion 3. The estimated PCB load from the City's CSOs (excluding MS4) represents 31.5% of the target instream loads.
   b. Ecology estimated PCB load from City's RPWRF at 194 mg/day based on mean total PCB concentrations and instantaneous flows from data collected in 2001, 2003, and 2004 and presented in Ecology's PCB Source Assessment study (Ecology 2011a). The RPWRF estimated PCB load of 194 mg/day exceeds the target in-stream load of 114 mg/day at Ninemile monitoring location.
   c. Michael Baker estimated current (2014-2018) average PCB loads from the City's RPWRF to the Spokane River at 77.5 mg/day (Appendix H-3). The current estimated RPWRF PCB load is 68.0% of the target in-stream load of 114 mg/d. Derivation of calculations are further discussed in Bowdan's Opinion 3.

2. PCBs are present in discharges of City's CSOs and treated RPWRF effluent to the river.
   a. Ecology summarized PCB concentration data for four of the existing CSO outfalls over the period 2003 through 2007 in the Ecology PCB source assessment as follows:
      i. Tables 23 through 25 (Ecology 2011a) show measured PCB concentrations for CSO 7 ranging from 749 pg/L to 4,520 pg/L.
      ii. Tables 23 through 25 (Ecology 2011a) show measured PCB concentrations for CSO 24A ranging from < 80 pg/L to 4,867 pg/L.
      iii. Tables 23 through 25 (Ecology 2011a) show measured PCB concentrations for CSO 26 ranging from 991 pg/L to 7,707 pg/L.
      iv. Tables 22, 23, and 25 (Ecology 2011a) show measured PCB concentrations for CSO 34 at 83,400 pg/L, 280,430 pg/L, and 72,686 pg/L, respectively.

   Although the limited data are variable from four sampled CSO basins, the Ecology data demonstrate that PCBs are present in CSOs from the City and PCB concentrations in discharges from the City's CSOs far exceed the current HHC of 7 pg/L.

   b. Ecology summarized PCB concentration data collected at the RPWRF treated effluent from 2001 -2004 as part of the PCB source assessment. Table 38 in Ecology (2011a) shows the mean total PCB concentration in RPWRF treated effluent as 1,364 pg/L. The data demonstrates that PCBs are present in the treated effluent from the City-owned and -

operated RPWRF and that the measured PCB concentrations in the discharge from the RPWRF exceed the HHC of 7 pg/L.

c. I have reviewed wastewater influent and treated effluent PCB data received from the City of Spokane (PCB Database v26) and updated by Limnotech (September 7, 2019) with v27 corrections to the RPWRF 2011 2012 effluent data (hereafter referred to as Spokane PCB database v27). From data contained within the PCB database v27, I prepared a consolidated spreadsheet (Appendix H-1) consisting of the following specific data:

   i. RPWRF effluent wastewater total PCB data from 2001 through 2007 (3X blank censored and with below detection limit values set to zero).

   ii. RPWRF effluent wastewater total PCB data from 2011-2012 and 2014-2018 (3X blank censored and with below detection limit values set to limit/2).

   iii. RPWRF influent wastewater total PCB data from September 2011-December 2018 (10X blank censored and with below detection limit values set to zero)

   My review and analysis of the Appendix H-1 consolidated data indicates that PCB concentrations in the influent from the City's wastewater collection system remain high. The data show that PCB concentrations in the CSS influent flow to the RPWRF range between 2,484 pg/L to 50,088 pg/L with a calculated arithmetic mean (average) concentration of 13,452 mg/L. Furthermore, the data show that RPWRF treated effluent PCB concentrations range from 114 pg/L to 2,410 pg/L with an arithmetic mean concentration of 758 pg/L. These data provide a recent picture of the range and average concentrations of total PCBs present within the City's CSOs (based on the influent data) and RPWRF treated effluent flows to the river.

3. Based on the concentrations of total PCBs in the CSOs as presented in Bowdan's Opinions 1.1 and 1.2, discharges from the City's CSOs and RPWRF contribute significantly to PCBs in the river which cause impairments in the beneficial uses of the river. Without reduction of PCB load from the City's CSOs, and without construction and operation of technically feasible treatment solutions to reduce PCB load in the RPWRF discharge, the impairments cannot be fully addressed, and the beneficial uses cannot be completely restored.

Bowdan's Opinion 2 – As the owner and operator of the CSS and RPWRF, the City is and will continue to be obligated to reduce and eliminate PCB discharges to the river from the City-owned and -operated facilities toward compliance with the PCB HHC.

1. As the owner and operator of the CSOs and RPWRF, the City is required to mitigate its contribution of PCBs via the City-owned and -operated CSS and RPWRF to the river in order to achieve compliance. As discussed in Bowdan's Opinion 1, the City's contribution of PCBs from its CSOs and RPWRF to the river is significant and the reduction of City's PCB loading from the CSOs, coupled with ongoing improvements to construct technically feasible improvements to reduce PCB loading

from the RPWRF effluent, is critical to achieve the HHC of 7 pg/L in the river and restore beneficial uses of the river.

2. Trapp's Opinion 4.2 indicates that instream PCB concentrations in the Spokane River already exceed the PCB HHC of 7 pg/L. See Trapp's Opinion 4.2 for further details.
3. Due to the fact that PCBs are already present in the receiving water at levels exceeding the HHC, the City will be required to reduce or eliminate CSO PCB discharges from all of the City-owned and -operated CSO outfalls by reducing the discharge frequency from each controlled CSO outfall. This would primarily be accomplished by the City's current CSO reduction effort which minimizes overflows from each CSO outfall to not more than one per year based on a 20-year moving average period (Ecology 2011b). Furthermore, the controlled CSO discharge must only be that caused by excessive precipitation events that would otherwise overwhelm the CSS and main interceptor pipeline (I02) which conveys the CSS flow to the RPWRF (Ecology 2011b, CH2MHill 2014b). The combination of previous and ongoing projects undertaken by the City to reduce CSOs are enumerated in the City's 1994 CSO Reduction Plan, 2005 CSO Reduction Plan Amendment, and the latest 2014 CSO Reduction Plan Amendment (CH2MHill 2013, 2014b, City of Spokane 2019g). The result of previous and ongoing efforts by the City to reduce CSOs is the steady reduction of CSOs to the river from the City-owned and -operated CSS coupled with the diversion of those CSS flows to the RPWRF for treatment. Details of the City's efforts to reduce CSOs and improve treated quality at the RPWRF are discussed in greater detail in Bowdan's Opinion 3.
4. Due to the fact that PCBs are already present in the receiving water at levels exceeding the HHC (Trapp Opinion 4.2), the City is required to reduce PCB discharges from the City-owned and -operated RPWRF outfall by constructing, maintaining, and operating technically feasible treatment system improvements and providing continuous advanced treatment of the CSS flows at the City-owned and -operated RPWRF to reduce PCB concentrations in the treated effluent toward the ultimate goal of meeting the PCB HHC of 7pg/L.
5. Regarding the reduction of PCBs at the City-owned and -operated RPWRF, no treatment technology is currently available to reliably and consistently reduce the concentration of PCBs in the RPWRF treated effluent to 7 pg/L. As presented in Trapp's Opinion 2.5, pertinent to City's application for an individual discharger variance from the PCB HHC, the City evaluated various options/technologies to reduce PCBs in discharges from City's RPWRF to the PCB HHC of 7 pg/L and determined that no feasible options and technologies are currently available to bring PCB concentrations to 7pg/L (City of Spokane 2019c).
6. Because no current feasible technology is available to reliably and consistently treat the effluent from the City-owned and -operated RPWRP to the level of the PCB HHC of 7 pg/L, the City, with approval from Ecology, is constructing improvements to the RPWRF that include the addition of chemically enhanced primary treatment (CEPT), NLT 50-million gallons per day (MGD) tertiary membrane treatment system, and other plant improvements that will provide the best combination of total phosphorus (TP), 5-day carbonaceous biochemical oxygen demand ($CBOD_5$), ammonia, and PCB removals based on a "net environmental benefit" approach that is technically and financially feasible (CH2MHill 2014a, 2014b). While the net environmental benefit approach was originally intended to address the best means of meeting the waste load allocations (WLAs) of the Spokane River and Lake Spokane dissolved oxygen (DO) TMDL requirements, the benefits of the selected treatment system for enhancing PCB reduction in the RPWRF effluent are noted

in subsequent planning documents (CH2MHill 2014a, 2014b). The specific improvements undertaken by the City at the City-owned and -operated RPWRF coupled with an analysis of the projected PCB removal effectiveness of the proposed treatment improvements are discussed in Bowdan's Opinion 3.

Bowdan's Opinion 3 – Due to City's ownership of the CSS and RPWRF, the city is required to mitigate their contributions of PCBs to the river via discharges from the city-owned and -operated CSS and RPWRF.

1. As stated in Bowdan's Opinion 1, the overflows from the City-owned and -operated CSS outfalls are a major contributor of PCB load to the Spokane River. Bowdan's Opinion 2 presents the City's requirements, in the light of the receiving waters exceeding the PCB HHC, to treat CSO discharges to receiving water standards or eliminate discharges by diverting CSS flows to the RPWRF and providing enhanced treatment at the RPWRF to ultimately meet regulatory compliance. Because no technology is technically or financially feasible to treat CSO discharges to the required level at each CSO outfall, the City has implemented an approach that will significantly reduce CSO discharges by: 1) separating the CSS by removing storm water discharges to the sanitary sewers where practical; 2) diverting CSS flows to the RPWRF; and 3) constructing CSO controls (inline storage, flow regulators, and weir modifications, etc.) to reduce the magnitude of peak CSS flows to the RPWRF. The combination of previous and ongoing projects undertaken by the City to reduce CSOs are enumerated in the City's 1994 CSO Reduction Plan, 2005 CSO Reduction Plan Amendment, and the latest 2014 CSO Reduction Plan Amendment[10] (City of Spokane 2014b, 2018)
    a. CSO reduction has been an active part of the City's history since the early 1970s. During that time, it was estimated that an average of nearly 1,000 CSO events with up to 570 million gallons (MG) of combined sewage were released to the river annually from 44 CSS outfalls. Sewer Overflow Abatement Plans developed in the late 1970s led to partial separation of the combined sewers in the northern part of the City in the 1980s. The City's 1994 CSO Reduction Plan (and subsequent 2005 CSO Reduction Plan Amendment) established a program with a 20-year schedule for reducing CSOs to the Spokane River (City of Spokane 2015, 2019g). Based on the 1994 CSO Reduction Plan and 2005 CSO Reduction Plan Amendment, the following major projects were completed between 2000 and 2012 (City of Spokane 2015b, CH2MHill 2013):
        i. Six (6) CSO control facilities were constructed at CSO Outfalls 2, 10, 16, 19, 38, and 42. These facilities provide storage tanks to accommodate excess CSS flow caused by precipitation events for controlled release to the CSS interceptor.
        ii. Weir modification, replacement of old flow regulators, and installation of new flow regulators at CSO Outfalls 6, 7, 14, 15, 25, 26, 39, and 40. These facilities provided improved control of CSS flow prior to adding storage to the CSS.
        iii. Physical elimination of CSO Outfalls 3, 18, 39, and 40.

[10] The City of Spokane Integrated Clean Water Plan and later documents refer to the Final 2013 CSO Plan Amendment (dated March 2014) as the 2014 CSO Plan Amendment.

iv. Physical plugging of CSO outfalls 16a and 16c (Note: CSO 16 continues to use Outfall 16b).

City's efforts through 2012 led to significant reductions in average annual CSO events (250) and overflows to the river (79 MG) (CH2MHill 2014b).

b. Since 2012, the City has eliminated CSS Outfall 12, with CSS Outfall 20 expected to be eliminated as part of a future project (City of Spokane 2017, 2019g).

c. The City prepared its 2014 CSO Plan Amendment with the stated purpose to "document modifications to the City's CSO Program. These modifications are the result of revised requirements in the City's 2011 Spokane National Pollutant Discharge Elimination System (NPDES) permit for CSOs, improvements to planning tools (specifically computer models, monitoring data, and meteorological records), additional information about the performance of built storage facilities and weir modifications, and other progress made on CSO control within the City of Spokane (including resulting improvements to CSO control status). This document amends the 2005 Combined Sewer Overflow Reduction System Wide Alternative Report, which has served as the City's CSO planning document since 2005. The principal change to the 2005 Plan as a result of these revised requirements and additional information is revision of storage facility volumes necessary to control the outfalls to the NPDES performance standard of one overflow per year on a 20-year moving averaging period…" (City of Spokane 2015). The 2014 CSO Plan Amendment resulted in the "refining"[11] of CSO control project storage volumes and regulator settings but did not include recommendations for the inclusion of green infrastructure (GI) improvements such as bioinfiltration swales and infiltration of stormwater separation from some CSS basins (CH2MHill 2014a, 2014b). The City's 2014 Integrated Clean Water Plan utilized a consolidated approach to merge CSO reduction improvements with green infrastructure improvements to reduce, remove, and/or treat stormwater inflows to the existing CSS where feasible (CH2MHill 2014b). Table 12 was compiled by Michael Baker to provide a complete listing of the CSO reduction and CSO related green infrastructure projects along with relevant project information and construction completion status:

[11] The 2014 CSO Plan Amendment did not reevaluate the CSO control technologies that were previously recommended in the 2005 CSO Plan; rather, the recommended control storage volumes were revised (refined) based on the availability of more accurate historical meteorological records and data, City experience with completed CSO control facilities, revision to the CSO performance standard, and updated CSO modeling results (CH2MHill 2014a, City of Spokane 2015, 2019g).

TABLE 12. CITY OF SPOKANE CSO REDUCTION PROJECTS 2002 TO PRESENT

Basin No.	Type of Improvements[1]	Year Completed[1]	Volume (Gallons)[1]
CSO Basin Areas			
2	CSO storage basin with elimination of CSO Outfall 03	2003	367,000
6	CSO storage basin with new interceptor inlet control near CSO 7	2015	900,000
7	CSO control with new interceptor inlet for CSO 6 and 7	2016	10,000
10	CSO storage basin	2011	137,000
12	CSO storage basin with interceptor inlet near CSO 10	2017	700,000
14	Bioinfiltration to remove, treat and infiltrate stormwater from street inlets and remove from CSO	2018	51,000
15	Bioinfiltration to remove, treat and infiltrate stormwater from street inlets and remove from CSO	2018	56,000
16	CSO storage basin	2007	194,000
19	CSO flow control (weir modification)	2010	5,000
20	CSO storage basin with partial separation of stormwater in CSO 20 and 24 basins to drywells and swales. CSO Outfall 20 elimination is expected as part of a future project.	2016	205,000
23	CSO storage basins (2)	2018	51,000
24	CSO storage basin	2018	2,400,000
25	CSO storage basin with partial separation of stormwater to swales	2018	43,000
26	CSO storage basin	2019[3]	2,200,000
33-1	CSO storage basin	2018	2,040,000
33-2	CSO storage basin	2015	254,000
34-1	CSO storage basin for CSO Basin 34 and interceptor storage protection for I-07	2019[3]	1,700,000
34-2	CSO storage basin	2015	1,430,000
34-3	CSO storage basin	2014	1,040,000

Basin No.	Type of Improvements[1]	Year Completed[1]	Volume (Gallons)[1]
38	CSO storage basins (2) for CSO 38 and 39, and inline storage for CSO 40, with elimination of CSO Outfalls 39 and 40	2012	365,000
41	CSO storage basin	2017	100,000
42	CSO storage basin	2009	110,000
		Total CSO Storage	***14,358,000***
	Incomplete Isolation Areas[2]		
IO3	Interceptor storage protection for Interceptor I03	2018	1,240,000
IO4	Interceptor storage protection for Interceptor I04	2017	800,000
IO7	Included in CSO 34-1	2019[3]	
		Total Incomplete Isolation Area Storage	***2,040,000***
		Total CSO Related Storage	***16,398,000***

Notes:
1. Source of data: 2012, 2014, 2015, 2016, 2017, and 2018 Annual CSO Reports; 2014 CSO Plan Amendment (City of Spokane 2013, 2015b, 2016a, 2017, 2018, 2019g, CH2MHill 2013).
2. Incomplete Isolation Areas are separated storm systems within CSO areas that discharge only to a combined sewerage interceptor. These Incomplete Isolation Areas do not have an outfall to the Spokane River; therefore, they are included as part of the CSS.
3. Completion dates are estimated for 2019 projects.

d. Separation of the City's wastewater collection system has also been ongoing since the mid-1980s. At the end of 2012, the City's wastewater collection system contained approximately 871 miles of sanitary sewer pipe comprised of 471 miles of separated sewers, 400 miles of combined sewers, and 20 CSO outfalls (CH2MHill 2014b). By the end of 2018, the City's wastewater collection system increased to a total of about 863 miles of sanitary sewers with a reduction in the number of CSO outfalls from 20 to 19 (City of Spokane 2019g). The City expects further reduction in the number of CSO outfalls from 19 to 18 during 2019 with the anticipated elimination of CSS Outfall 20.

e. The result of the foregoing improvements undertaken by the City to the City-owned and -operated CSS is the significant reduction of CSO related PCB discharge to the river by the storage, diversion and control of CSS flows via the CSS interceptors to the RPWRF. The calculated PCB reduction is provided later in this opinion.

2. As stated in Bowdan's Opinion 1, treated effluent and primary treated CSO bypass from the City's RPWRF are major contributors of PCB load to the Spokane River.
   a. Bowdan's Opinion 2 presents the City's requirements, in light of the receiving waters exceeding the PCB HHC of 7 pg/L, to treat RPWRF discharges to ultimately meet regulatory compliance.

b. As no existing treatment technology is currently technically or financially feasible to consistently and reliably treat CSO discharges to the required level at each CSO outfall, the City is utilizing its Amended CSO Reduction Plan, based on a "net environmental benefit approach", to reduce CSO discharges to the river, redirect CSS flows to the RPWRF, and install treatment system improvements at the RPWRF that will also result in the minimization of PCB loading to the river. This approach has been developed by the City in collaboration with Ecology (City of Spokane 2015a, CH2MHill 2014a).

c. Furthermore, the City has recently applied for an individual discharger variance from the PCB HHC in accordance with variance regulations at Washington Administrative Code (WAC) 173-201A-420 and EPA's variance regulations at 40 C.F.R. § 131.14 (City of Spokane 2019c). As part of the requested variance, the City proposes a 20-year individual discharger variance with the interim highest-attainable effluent PCB condition of 792 pg/L. As required by rule, if granted, the PCB HHC variance would be reviewed every five years by Ecology for renewal consideration (City of Spokane 2019c).

d. Subject to Ecology's review of the variance following each 5-year period, Ecology may lower the interim highest attainable PCB condition based on the actual monitored performance of the RPWRF. Furthermore, the City may be required to provide additional future improvements to the RPWRF once a technically feasible technology becomes available to consistently and reliably reduce PCB loading in the RPWRF effluent to meet the PCB HHC of 7 pg/L.

3. The NLT project currently being constructed by the City at the RPWRF was developed based on more than 10 years of study and evaluation of the NLT project (CH2MHill 2014a). The NLT project will construct the wastewater treatment processes necessary to allow the RPWRF treated effluent to comply with the WLAs of the Spokane River and Lake Spokane DO TMDL for TP, $CBOD_5$, and ammonia (CH2MHill 2014a). The NLT will also provide PCB reduction "since PCBs tend to adhere to the particulate portion of the waste stream…" and will thus be removed by the filtration of solids (City of Spokane 2016b).

   a. The improvements at the City-owned and -operated RPWRF are being performed in general conformance with the revised design criteria established in the NLT Engineering Report/Wastewater Facility Plan Amendment No. 3 (CH2MHill 2014a, City of Spokane 2019c). Design refinement of the various NLT treatment components is based on extensive pilot testing performed as part of the tertiary membrane system procurement process (early 2015 through mid-2016) to determine the optimized operational requirements for effective TP removal effectiveness, primary and secondary chemical coagulant dosing, and membrane cleaning (CH2MHill 2015, O'Connell et al 2016). Based on this design refinement, the NLT project, which is currently under construction, will include the following major components:

      i. Construction of new 0.9 MG Primary Clarifier No. 5 and conversion of an existing CSO clarifier to Secondary Clarifier No. 5 to increase peak primary and secondary treatment capacity to 125 MGD. This increase in plant capacity, coupled with ongoing CSS control improvements to significantly reduce CSOs to the river and reduce peak CSS flow within Interceptor I-02 to about 120 MGD, will allow for full

treatment of nearly all CSS flow to the plant and further reduction in Treated CSO Bypasses at the RPWRF.

ii. Reconfiguration of an existing 2-MG CSO clarifier to allow temporary diversion and storage of CSS influent flow in excess of 125 MGD to the plant. Up to the first 2 MG of excess flow diverted to the CSO clarifier is pumped back to the headworks following a storm event to receive full treatment. Volumes greater than the available 2 MG of CSO storage would receive CEPT followed by disinfection prior to discharge to the river[12].

iii. Construction of a new tertiary pretreatment system consisting of 0.5 mm mesh drum screens, flash mix system, and flocculation system. The drum screens will remove debris larger than 0.5 mm to protect the membrane filtration system. The flash mix system will provide the energy and detention time necessary to completely and uniformly mix chemical coagulant into the screened secondary influent stream. The flocculators will allow time for chemical reactions to occur to convert most of the soluble phosphorus into particles large enough to be removed by the membrane filtration system. The tertiary pretreatment system will have a peak capacity of 75 MGD net filtrate with space to allow for expansion of the pretreatment system to a future peak capacity of 125 MGD of filtrate.

iv. Installation of a new 50-MGD firm net filtrate capacity pressurized microfiltration (MF) tertiary filter system with 75 MGD peak net filtrate capacity[13]. The membrane filtration system removes solids particles and PCBs that have adsorbed to the surfaces of the removed solids. The pressurized tertiary membrane system will include a membrane feed pump station to pump the screened and chemically conditioned flow through the membrane filtration system. Space is provided at the RPWRF to allow for future expansion of the NLT to 81.7 MGD firm net filtrate capacity with a 125 MGD peak net flow capacity.

v. Installation of new chemical storage and injection facilities to provide CEPT to assist with both phosphorus and PCB removal (CH2MHill 2014a, 2015).

vi. Hereinafter, the initial phase NLT project, which is currently under construction and will have a firm net capacity of 50 MGD and a peak filtrate capacity of 75 MGD, will be referred to as 50/75 MGD NLT. The potential future expansion of the NLT to a firm net capacity of 81.7 MGD and peak net capacity of 125 MGD will be referred to as 81.7/125 MGD NLT.

b. The initial 50/75 MGD NLT was determined by net environmental benefit analysis to provide the best combination of technically and economically feasible treatment to

[12] CEPT is only required during the critical season to meet total phosphorus (TP) annual loading limit to the Spokane River. However, to increase both TP and PCB removal annually, CEPT is currently being planned year round (i.e. during the critical and non-critical season) in lieu of part-year critical-season-only operation (City of Spokane 2016b).

[13] Firm capacity is the capacity of the membrane system with one membrane train not processing flow while deconcentrating solids and one membrane train out of service for maintenance. Net [or filtrate] capacity is the feed flow capacity minus the flow resulting from recirculating solids (CH2MHill 2014a). Feed flow is the incoming flow to the membrane system inclusive of recirculating flow.

comply with the WLAs of the Spokane River and Lake Spokane DO TMDL for $CBOD_5$, ammonia, and TP (CH2MHill 2014a). The 50/75 MGD NLT will be capable of removing TP to an average concentration of 18 ppb[14] (CH2MHill 2015). Pilot testing confirmed that the selected pressurized tertiary membrane filtration technology will consistently remove TP to <18 ppb (Pall 2016a). The confirmed membrane system performance will allow the 50/125 MGD NLT to meet the stringent TP TMDL of 17.8 lbs/day (equivalent to effluent TP concentration of 42 ppb) (CH2MHill 2015). Although the City has evaluated future expansion of the NLT to 81.7/125 MGD, the City is not currently required to implement the future expansion.

c. The City would only be required to operate the CEPT and NLT tertiary membrane system during the eight-month critical season to meet WLAs of the Spokane River and Lake Spokane DO TMDL; however, CEPT and NLT tertiary membrane operation would be required to be maintained year-round (i.e., additional operation during the four-month non-critical season), in order to provide maximum PCB removal and further reduce PCB load to the Spokane River (CH2MHill 2014a, Spokane 2016b).

d. Ecology will continue to evaluate the actual PCB removal performance of the City's RPWRF 50/75 MGD NLT over several years, subsequent to NLT project completion and start-up, in order to establish an interim maximum concentration-based or load-based PCB limit (performance limit) for the RPWRF treated effluent (City of Spokane 2019c). Implementation of such a performance-based PCB limit would require Ecology to approve the PCB Variance Application recently submitted by the City (2019c). Furthermore, since a variance must be reviewed every 5-years, Ecology would need to approve future City requests for variance to the current PCB HHC of 7 pg/L. Future PCB variance requests are not guaranteed to be approved. In the case where a future PCB variance is not approved, the City would be required to comply with the PCB HHC in affect at that future time.

e. Depending on the result of the PCB removal performance evaluation, or other evaluations related to compliance with the WLAs of the Spokane River DO TMDL, excessive treated CSO bypasses may trigger the need for the City to expand the NLT to the 81.7/125 MGD ultimate capacity. The future expansion, if required, would allow the entire treatment train (primary, secondary and NLT tertiary) to be capable of treating peak wet weather CSS flow to the plant of up to 125 MGD resulting in the elimination of Treated CSO Bypasses at the RPWRF. The capital and operation and maintenance cost of expanding the tertiary treatment system to the 81.7/125 MGD NLT would ultimately be incurred by the City and would provide further PCB removal capability. The percentage of the 81.7/125 MGD NLT expansion capital cost that would benefit PCB removal cannot be quantified at this time and is not included in the cost evaluation provided in Bowdan's Opinion 4.

f. In the event that the PCB HHC of 7 pg/L (or 170 pg/L) remains in intact for the foreseeable future, the City may be required to investigate and eventually construct, operate, and maintain additional treatment technologies in the future at the RPWRF toward meeting the PCB HHC. The cost of investigations, pilot testing, preliminary and final design,

[14] 1 ppb (part per billion) is equal to 1µg/L or 0.001 mg/L.

construction, start-up, and the operation and maintenance of future treatment system would ultimately be incurred by the City in order to comply with the PCB HHC. The cost of such investigations, pilot testing, preliminary and final design, construction, start-up, and the operation and maintenance of future viable PCB removal technologies cannot be quantified at this time and is not included in the cost evaluation provided in Bowdan's Opinion 4.

4. PCB loads from the City-owned and -operated CSS and RPWRF were calculated.
   a. A detailed analysis, utilizing a spreadsheet-based model, was prepared as part of this expert report to quantify the benefits of the City's ongoing efforts to reduce PCB loads by reducing CSOs and by enhancing treatment at the RPWRF. The modeling analysis included the following evaluations:
      i. Baseline condition establishing approximate PCB loading to the Spokane River from the CSS based on sampled CSO and RPWRF effluent data for the period 2003 through 2007;
      ii. Interim condition establishing approximate PCB loading to the Spokane River from the CSS based on recorded CSO and RPWRF effluent data for the period 2011 and 2012;
      iii. Current condition (2014 through 2018) representing the net effects on PCB loading to the Spokane River based on CSS and RPWRF improvements completed to-date; and,
      iv. Future conditions representing the net effects on PCB loading to the Spokane River based on the future completion of CSS and RPWRF improvements.
   b. This analysis consisted of the following main components:
      i. Determine typical PCB concentrations that can be assigned to flows within the CSS for the purpose of estimating the baseline (2003-2007), interim (2011-2012) current (2014-2018), and future PCB loads from CSO discharges.
      ii. Determine the PCB removal effectiveness of the primary, secondary, and tertiary treatment systems at the RPWRF to estimate the baseline (2003-2007), interim (2011-2012) current (2014-2018), and future PCB loads from RPWRF effluent discharge.
      iii. Calculate average annual volume of CSOs and RPWRF discharges.
      iv. Summarize the net reduction of PCB loads to the Spokane River resulting from current and future actions undertaken by the City to reduce and eliminate CSO discharges and enhance treatment effectiveness at the RPWRF.
   c. *CSO and RPWRF PCB Data*: Historical and ongoing PCB data from the RPWRF influent and treated effluent was received from Baron and Budd (PCB Database v27).
      i. The Spokane PCB database v27 data was compiled by Michael Baker into a consolidated Excel spreadsheet (Appendix H-1) as noted in Bowdan Opinion 1.2.c.
      ii. Unlike previous older data used in Ecology's Spokane River PCB TMDL Stormwater Loading Analysis (Parsons 2007) which contained limited sampling data for CSOs, the Spokane PCB database v27 data benefit from greater sampling frequency over a longer and more recent period. Furthermore, the data set is based on calculations of total PCB concentrations generally comprised of all 209 PCB

congeners organized by homologs for each sample and totalized to provide total PCB values.

iii. The Spokane PCB database v27 data were determined to be more representative and accurate data for use in preparing PCB loading calculations for past, current and future conditions in this analysis due to their more recent and theoretically more representative nature, large number of data available from the data set, and collection methodology as composite (representing sampling event mean PCB concentration). Furthermore, the RPWRF influent PCB data represent a composite of the PCB concentrations contributed by all CSO basins to the CSS and ultimately to the RPWRF over longer periods of time.

iv. For PCB load calculations, concentrations of all PCB homologs were summed as total PCB concentrations. PCB concentrations reported as less than detection limits were assigned with values as noted in Bowdan's Opinion 1.2.c.

v. Table 13 presents the number of data available for plant influent and influent locations as well as descriptive statistics including the minimum, maximum, and arithmetical mean of the respective data. These arithmetical means are used for all subsequent loading calculations in this analysis.

TABLE 13. AVERAGE PCB CONCENTRATIONS IN RPWRF INFLUENT AND TREATED EFFLUENT

Sample Date	Influent			Effluent		
	Total PCBs (pg/L)	Total PCBs (lbs/day)	Total PCBs mg/day)	Total PCBs (pg/L)	Total PCBs (lbs/day)	Total PCBs (mg/day)
Entire Period (2001-2018)						
Max	50,088	0.014206	6,446	2,410	0.000743	337.2
Min	2,484	0.000607	276	113	0.000028	12.8
Arith. Mean	13,452	0.003562	1,616	758	0.000201	91.1
Data Count	59	-	-	42	-	-
2001-2007						
Max	-	-	-	2,410	0.000743	337.2
Min	-	-	-	473	0.000141	63.8
Arith. Mean	-	-	-	1,361	0.000429	194.7
Data Count	-	-	-	6	-	-
2011-2012						
Max	25,630	0.006673	3,028	967	0.000260	118.2
Min	6,310	0.001620	735	527	0.000121	54.9
Arith. Mean	11,731	0.003650	1,656	728	0.000226	102.7
Data Count	12	-	-	8	-	-
2014-2018						
Max	50,088	0.014206	6,446	1,548	0.000465	211.0
Min	2,484	0.000607	276	113	0.000028	12.8
Arith. Mean	13,611	0.003575	1,622	634	0.000171	77.5
Data Count	39	-	-	26	-	-

d. *CSO Overflow Quantification*. CSO annual overflow volumes were obtained from the City's CSO Annual Reports for the baseline (2003-2007), interim (2012), and current (2018) conditions and estimated for the future condition.

i. The baseline condition utilizes the average of CSO basin annual overflow data for years 2003 through 2007 as summarized in Table 14.

TABLE 14. BASELINE CSO BASIN ANNUAL OVERFLOWS 2003-2007

CSO Outfall No	Baseline CSOs in MG/Year (2003-2007)					
	2003	2004	2005	2006	2007	Avg CSOs (MG)
002	0.000	0.000	0.000	0.000	0.000	0.000
006	3.740	3.890	5.489	9.335	1.652	4.821
007	0.257	0.264	0.351	0.348	0.143	0.273
010	0.136	0.144	0.220	0.344	0.120	0.193
012	3.254	1.876	3.407	5.918	1.447	3.180
014	0.172	0.180	0.189	0.273	0.050	0.173
015	0.114	0.314	0.154	0.149	0.119	0.170
016B	0.393	0.480	0.384	0.665	0.198	0.424
019	0.000	0.000	0.000	0.000	0.000	0.000
020	0.000	0.023	0.000	0.000	0.000	0.005
022B	0.010	0.004	0.001	0.033	0.104	0.030
023	1.486	1.641	1.823	2.436	0.815	1.640
024	4.169	10.525	5.246	15.949	8.105	8.799
025	0.435	0.336	0.368	0.530	0.138	0.361
026	15.396	17.650	17.733	31.020	12.522	18.864
033	2.170	6.914	7.068	19.672	3.078	7.780
034	13.232	18.295	15.290	28.111	7.803	16.546
038	0.149	0.602	0.155	0.564	0.061	0.306
041	0.132	0.682	0.461	0.878	0.223	0.475
042	0.000	0.000	0.127	0.011	0.000	0.028
Totals	**45.244**	**63.822**	**58.466**	**116.238**	**36.578**	**64.070**

ii. The interim condition utilizes CSO basin annual overflow data for 2012. Current condition utilizes the CSO basin annual overflow data for year 2018. Future conditions (2030) are based on all CSO control projects being complete. For the future condition, each CSO basin will experience not more than 1 overflow event based on a 20-year running average. The methodology used to estimate future CSO basin overflows is as follows:

1) Utilizing the baseline average number of annual overflows per basin (previously established by the City for the period 2003-2012), Michael Baker calculated the probability of 1 overflow event per year occurring for each individual CSO basin by taking the reciprocal of the baseline number of annual overflows.

2) The future overflow volume per CSO basin was calculated by multiplying the average baseline uncontrolled overflow volume (2003-2012) by the probability of overflow.

Based on the foregoing information, Table 15 provides a summary of actual CSO overflows for the interim condition (2012), current condition (2018) and projected overflows for the future condition (2030). Additionally, Table 15 provides the baseline annual number of overflows and overflow volumes for the period 2003-2012 along with the calculated probability of overflows which are used to calculate the future CSO annual overflows.

TABLE 15. INTERIM, CURRENT, AND FUTURE CSO BASIN ANNUAL OVERFLOWS

CSO Outfall No	Baseline Annual No. of Overflows[1]	Baseline Annual Overflows (MG/Year)[2]	Probability of Overflow per Year (%)[3]	CSOs (MG/Year)		
				Interim (2012)	Current (2018)	Future (2030)[3]
002	0	0.00	0.0%	0.000	0.000	0.000
006	27	4.81	3.7%	6.005	0.000	0.178
007	11	0.32	9.1%	0.689	0.072	0.029
010	10	0.15	10.0%	0.300	0.000	0.015
012	28	3.50	3.6%	4.953	0.000	0.125
014	14	0.11	7.1%	0.053	0.008	0.008
015	9	0.20	11.1%	0.024	0.000	0.022
016B	6	0.21	16.7%	0.000	0.000	0.035
019	0	0.00	0.0%	0.000	0.000	0.000
020	0	0.03	0.0%	0.108	0.000	0.000
022B	1	0.03	100.0%	0.000	0.000	0.030
023	16	1.07	6.3%	0.209	0.029	0.067
024	24	8.10	4.2%	11.002	3.234	0.338
025	22	0.42	4.5%	0.571	0.172	0.019
026	24	16.41	4.2%	19.501	36.140	0.684
033	25	7.21	4.0%	11.561	0.727	0.288
034	19	13.82	5.3%	18.016	1.021	0.727
038	10	0.19	10.0%	0.075	0.000	0.019
041	12	0.39	8.3%	0.340	0.000	0.033
042	1	0.02	100.0%	0.000	0.000	0.010
Totals	**--**	**56.99**	**--**	**73.407**	**41.403**	**2.627**

Notes:

1. Baseline annual number of overflows based on average of overflow events per basin for the period 2003-2012 (City of Spokane 2015).
2. Baseline annual overflows based on average of annual CSOs for the period 2003-2012 (City of Spokane 2015).
3. Future projections are estimated by averaging the 2012 and 2016-2018 and multiplying the result by the probability of overflow. The probability of overflow in the future is calculated by taking 1 divided by the baseline annual overflows (2003-2012). This methodology allows for not more than 1 overflow per year per outfall.

e. *CSO PCB Loading*. CSO loading was determined as follows based on the period.

   i. *Baseline (2003 – 2011)*. CSO PCB loading was calculated for each of the CSO basins by utilizing estimated PCB concentrations from Ecology (2011a) Table 39 for CSOs 7, 24A, 26, and 36, and Table 40 for remaining CSOs, along with the CSO basin average overflows for the baseline period (2003-2007) from Bowdan Table 14 and applying the equations listed in Bowdan ‘s Opinion 3.4.2.iii.

   ii. *Interim (2012), Current (2018) and Future (2030).* CSO PCB loading was calculated for each of the CSO basins by utilizing the RPWRF Plant Influent PCB arithmetic mean concentrations for each period (interim, current, and future) summarized in Table 13 and the CSO basin annual overflow volumes from Table 15 for the respective periods and applying the equations listed in Bowdan ‘s Opinion 3.4.2.iii.

   iii. *CSO PCB loading equations are as follows:*
   PCB Load (lbs/yr) = Annual CSO (MG) x [PCB Conc (pg/L) / 1E09 (pg/mg)] x 8.345

   PCB Load (mg/day) = PCB Load (lbs/year) x (1E06 mg/2.204 lbs) x (1 yr/365 days)

f. Calculated CSO PCB loads are summarized in Table 16 for the baseline (2003-2007) period and Table 17 for the interim (2012), current (2018), and future (2030) periods. Total CSO PCB loads for the baseline, interim, current, and future periods are calculated as 35.95 mg/day, 8.93 mg/day, 5.85 mg/day, and 0.37 mg/day, respectively. Based on the City’s efforts to date, the continuing implementation of CSO controls has resulted in a decrease of 83.7% in PCB loading to the Spokane River comparing the current to the baseline condition. Furthermore, at the completion of the CSO elimination program, projected CSO basin overflows will be greatly diminished resulting in an overall 99.0% decrease in PCB load to the Spokane River when comparing the future and baseline conditions.

TABLE 16. CSO AVERAGE DAILY PCB LOADS FOR BASELINE (2003-2007)

CSO Outfall No	Baseline CSOs (2003-2007)		
	Avg CSOs (MG)	Est. PCB Conc (pg/L)	PCBs (mg/day)
002	0.000	23,000	0.0000
006	4.821	23,000	1.1502
007	0.273	2,490	0.0070
010	0.193	23,000	0.0460
012	3.180	23,000	0.7587
014	0.173	23,000	0.0413
015	0.170	23,000	0.0405
016B	0.424	23,000	0.1012
019	0.000	23,000	0.0000
020	0.005	23,000	0.0011
022B	0.030	23,000	0.0073
023	1.640	23,000	0.3913
024	8.799	2,560	0.2336
025	0.361	23,000	0.0862
026	18.864	3,380	0.6613
033	7.780	23,000	1.8561
034	16.546	177,000	30.3762
038	0.306	23,000	0.0730
041	0.475	23,000	0.1133
042	0.028	23,000	0.0066
Totals	**64.070**	**54,100**	**35.951**

TABLE 17. CSO AVERAGE DAILY PCB LOADS FOR INTERIM, CURRENT, AND FUTURE

CSO Outfall No	Interim (2012)		Current (2018)		Future (2030)	
	CSOs (MG)	PCBs (mg/day)	CSOs (MG)	PCBs (mg/day)	CSOs (MG)	PCBs (mg/day)
002	0.000	0.0000	0.000	0.0000	0.000	0.0000
006	6.005	0.7306	0.000	0.0000	0.178	0.0249
007	0.689	0.0839	0.072	0.0102	0.029	0.0041
010	0.300	0.0365	0.000	0.0000	0.015	0.0021
012	4.953	0.6027	0.000	0.0000	0.125	0.0174
014	0.053	0.0065	0.008	0.0012	0.008	0.0011
015	0.024	0.0030	0.000	0.0000	0.022	0.0031
016B	0.000	0.0000	0.000	0.0000	0.035	0.0049
019	0.000	0.0000	0.000	0.0000	0.000	0.0000
020	0.108	0.0131	0.000	0.0000	0.000	0.0000
022B	0.000	0.0000	0.000	0.0000	0.030	0.0042
023	0.209	0.0255	0.029	0.0041	0.067	0.0093
024	11.002	1.3387	3.234	0.4565	0.338	0.0471
025	0.571	0.0694	0.172	0.0242	0.019	0.0027
026	19.501	2.3728	36.140	5.1019	0.684	0.0954
033	11.561	1.4067	0.727	0.1026	0.288	0.0402
034	18.016	2.1921	1.021	0.1441	0.727	0.1015
038	0.075	0.0091	0.000	0.0000	0.019	0.0027
041	0.340	0.0413	0.000	0.0000	0.033	0.0045
042	0.000	0.0000	0.000	0.0000	0.010	0.0014
Totals	**73.407**	**8.932**	**41.403**	**5.845**	**2.627**	**0.3665**

g. *RPWRF Treated Effluent PCB Loading*. Treated Effluent PCB loads from the City-owned and -operated RPWRF were calculated by first determining the estimated PCB removal efficiencies in each treatment step as follows:

i. *Primary Treatment.* The City began implementing CEPT about 2011 as part of a full-scale pilot test to determine the ability to enhance phosphorus removal. CEPT involves the injection of alum at the headworks followed polymer addition at the flow distribution box of the primary clarifiers. Pilot testing for the selected membrane manufacturer concluded that CEPT must be maintained with alum dosage between 40-50 mg/L in order to maintain the ability of the NLT membrane system to achieve the TP TMDL of < 18 ppb (O'Connell et al. 2016). Furthermore, based on pilot testing performed by Morris and Lester (1994), it was concluded that the effectiveness of PCB removal through primary sedimentation in a wastewater treatment plant averages about 45%.

ii. *Secondary Treatment.* During PCB sampling as part of the early NLT pilot testing performed by Esvelt Environmental Engineering (2014), the total PCB removal efficiency through the combination of the primary and secondary treatment trains at the existing RPWRF was found to range from about 90% to 93%. Actual analysis of the PCB sampling data compiled in Bowdan Appendix H-1 for the period 2001 through 2018 shows the arithmetic mean PCB removal efficiency through the existing primary and secondary treatment trains is 94.4%, with 25th and 75th percentile removals of 91.3% and 97.0% respectively.

iii. *NLT Tertiary Treatment.* During PCB sampling as part of the early NLT pilot testing performed by Esvelt Environmental Engineering (2014), the total PCB removal efficiency through the proposed NLT treatment train was found to average about 80% with a range of 73.4% to 98.8%. Based on the limited PCB testing and the variable range of the PCB analytical results, this analysis uses a conservative NLT removal efficiency of 70%.

iv. *Estimated Secondary Bypass of the 50/75 MGD NLT.* The 50/75 MGD NLT design was selected using a net environmental benefit analysis as previously noted on Bowdan's Opinion 3 (paragraph 3.b). Because the NLT firm and peak capacities are less than the 125 MGD primary and secondary treatment capacity, certain wet weather and/or high Spokane River stage events could cause plant flow that would exceed the capacity of the NLT. Under this condition secondary treated effluent would bypass the NLT to disinfection and then discharge. This condition is called Secondary Treated Bypass and is estimated to produce a volume equivalent to about 1.0% of the average annual flow.

v. *Estimated Secondary Bypass of the 81.7/125MGD NLT.* The 81.7/125 MGD NLT may be provided as part of a future expansion of the NLT. This expansion of the NLT would allow the short-term peak capacity of the membrane system to match the peak capacity of the primary and secondary system. If the 81.7/125 MGD NLT expansion occurs, the Secondary Treated Bypass would be eliminated; therefore, the volume equivalent would be reduced to 0%.

vi. *RPWRF Average Flows*. The baseline (2001-2007) condition average annual influent flow to the RPWRF of 37.78 MGD is based upon the average flow of six effluent samples and instantaneous flow rates collected in 2001, 2003 and 2004 as part of the Ecology PCB source assessment (2011a). It is noted that the average flow rate during this period includes about 6.5 MGD of wastewater flow that since 2012 has been diverted to the County of Spokane wastewater treatment plan (WWTP) (CH2MHill 2014a). The interim (2011-2012) condition average annual influent flow to the RPWRF of 37.78 MGD is based on the average of recorded monthly flows for the noted period. The current (2014-2018) average influent flow of 31.47 MGD is based on the average of the instantaneous flows recorded during approximately 50 PCB influent and effluent sampling events during the period. The future (2030) conditions average annual influent flow rate is projected as 36.5 MGD based on NLT design planning (CH2MHill 2014a).

h. Using the foregoing estimated treatment efficiency information coupled with the respective average annual flow data and arithmetic mean influent PCB concentrations previously summarized in Table 13, the baseline, interim, current, and future PCB loadings from the RPWRF effluent discharge are summarized in Table 18. Total RPWRF effluent PCB loads for the baseline, interim, current, and future periods are calculated as 194.6 mg/day, 102.7 mg/day, 77.5 mg/day, and 27.5 mg/day, respectively. Based on the City's efforts to date, the continuing implementation of process improvements, such CEPT, to the RPWRF has resulted in PCB load reduction of 47.2% when comparing the interim and baseline conditions, and 60.2% when comparing the current and baseline condition. Furthermore, at the completion of the 50/75 MGD NLT project, the estimated reduction in PCB load will be 85.9% when comparing the future and baseline conditions. Expansion of the NLT to 81.7/125 MGD capacity would maximize total estimate reduction PCB load reduction to 86.3%.

TABLE 18. RPWRF AVERAGE DAILY PCB LOADS

Condition	Avg Influent Flow (MGD)	Daily Load (mg/day)
Baseline (2001-2007)	37.78	194.6
Interim (2011-2012)	37.28	102.7
Current Conditions (2014-2018)	31.47	77.5
Future Condition with 50/75 MGD NLT (2030)	36.5	27.5
Future Condition with 81.7/125 MGD NLT (Post 2030)	36.5	26.6

Bowdan's Opinion 4 - Due to City's ownership of the CSS and RPWRF and the requirement that the City mitigate their contributions of PCBs, the City of Spokane will incur ongoing operation and maintenance costs starting at $942,610 annually to maintain maximum PCB removal through the Non-Critical Season. Over a 30-year analysis period, the City will incur a total present worth cost of $29,782,000 to provide operation and maintenance of the NLT through the Non-Critical Season.

1. As stated in Bowdan's Opinion 2, the City, as owner and operator of the CSS and RPWRF, is required to reduce and eliminate PCB discharges to the river. Furthermore, as stated in Bowdan's Opinion 3, the City is required to construct and implement improvements to the CSS and RPWRF in order reduce and eliminate PCB discharges to the Spokane River.
    a. While it can be argued that the construction and installation of CSO controls within the City-owned and -operated CSS, coupled with construction of the 50/75 MGD NLT improvements to the City-owned and -operated RPWRF, are required to meet the WLAs of the Spokane River and Lake Spokane DO TMDL, it is imperative to note that continued operation of the CEPT and 50/75 MGD NLT will be required during the non-critical season to continue to remove PCBs to the lowest level attainable.
    b. The operation of the CEPT and NLT are not required to meet the DO TMDL during the non-critical season. Therefore, the additional operation and maintenance cost associated with continuing the operation of the CEPT and 50/75 MGD NLT during the 4-month non-critical season is an additional cost to the City that is directly related to the continuous reduction of PCB loads to the river from the RPWRF treated discharge.
2. Michael Baker calculated the additional operational and maintenance (O&M) costs due to the continued operation of the CEPT and 50/75 MGD NLT. The O&M costs associated with the operation of the NLT include the following:
    a. Chemical dosing.
        i. *Coagulation*. Alum is dosed ahead of the primary clarifiers for CEPT and after secondary for coagulation aid for NLT. For the purpose of this cost analysis, only costs associated with 25 mg/L Alum dosing to NLT are included.
        ii. *Enhanced Flux Maintenance*. Sodium Hypochlorite, Sodium Hydroxide, Citric Acid, and Sulfuric Acid are used for required enhanced flux maintenance (EFM) of the NLT membrane. An EFM is performed once each membrane rack has processed 6.48 MG of water. Under the average flow rate of 33.2 MGD during the non-critical season, a minimum of 5 membrane racks will undergo EFM daily.
        iii. *Recovery Clean*. Sodium Hypochlorite, Sodium Hydroxide, and Citric Acid are used to perform a recovery clean (as known as clean-in-place or CIP) of the membranes. Each membrane rack (total of 16) will undergo at least 1 recovery every 30 days.

iv. *Cleaning Solution Neutralization*. At the conclusion of an EAM or CIP, the cleaning solution may require neutralization before disposal. Sodium Bisulfite, Sodium Hydroxide, and Sulfuric Acid are used for this purpose.

v. All chemical batches used to create the EFM and CIP chemical solution are based on the use of 6,300 gallons per batch.

b. *Electrical, Gas and Water Use*. Electrical use was determined for the following major equipment based on motor sizes, duty percent, and average hours of operation per day:

i. Membrane Feed Pumps
ii. Reverse Filtration (RF) Pumps
iii. CIP Circulation Pumps
iv. CIP Tank Heaters
v. EFM Tank Heater
vi. Neutralization Drain Pumps
vii. Air Compressors
viii. Air Blowers with Aftercooler Fans
ix. Backwash Recycle Pumps
x. Drum Screen Drives
xi. Flash Mixers
xii. Flocculator Drives
xiii. Screenings Transfer Pump
xiv. Drum Screen Spray Pumps
xv. Miscellaneous Electrical Loads - Small Motors
xvi. Miscellaneous Electrical Loads - Control and Devices

c. *Building Energy Use*. Building energy use for electrical and gas consumption (lighting, ventilation, heating, air conditioning) was calculated based on the NLT building floor area of 43,000 square feet using Energy Information Administration Table C19 - Electrical Consumption, and Table C29 - Natural Gas Consumption. While a cost was computed for this category, **it is not included in the O&M cost development** since the NLT building will require this energy use whether or not the NLT equipment is operating during the non-critical season.

d. *Potable Water Use*. Potable water is used to provide the make up water for EFM and CIP chemical batches and for post chemical batch flushing. The water must be preheated for the chemical batch solutions. Natural gas is used to heat the water from an average temperature of 50 deg F to about 95 deg F. Water use for each EFM and CIP chemical batch is 12,600 gallons (make-up and flush rinse); however only 6,300 gallons is required to be heated per chemical batch.

e. *Labor*. The City will need to increase its labor force specifically to provide for the operation, maintenance, and monitoring of the NLT. Proposed 2020 labor rates and fringe benefits were provided by the City. Michael Baker calculated the burdened labor rate by inclusion of fringe benefits and taxes for each labor classification as provided in Appendix H-6. Michael Baker then selected applicable positions, classifications and step levels necessary to attract the type of qualified staffing that will be necessary for the NLT.

For the purpose of this analysis, a total of ten (10) new staffing positions will be necessary as follows:

i. *Instrumentation Repair Technician*: 2 total. This position is required to maintain, calibrate, update and repair the instrumentation system, control panels, field device, etc., that are used to measure, monitor, and control the various portions of the new NLT equipment. This is a single shift position but will require alternation of weekend and on-call work.

ii. *Maintenance Mechanic*: Two total. This position is required to maintain, adjust, repair the new NLT mechanical equipment including pumps, drives, piping, valves, blowers, compressors, fans, and other building mechanical equipment. This is a single shift position but will require alternation of weekend and on-call work.

iii. *Plant Operator*: Three total. This position is required for all three daily shifts. Operators are certified positions responsible for overseeing and monitoring the daily performance of the NLT and making necessary adjustments to ensure compliance of the treated effluent with regulatory permit requirements. The NLT will be required to be staffed by a Plant Operator at all times.

iv. *Operations Laborer*: Two total. This position provides miscellaneous maintenance and support to shift mechanics and performance of general labor necessary to maintain the NLT facilities in good working order. This is a single shift position but will require alternation of weekend and on-call work.

v. *Chemist*: One total. This position will be necessary to perform the range of new analytical sampling and lab work to confirm that the water quality is within the required effluent limits and prepare reporting for required compliance monitoring. This position is single shift and does not anticipate weekend work.

3. Based on the methodology and information provided in the foregoing discussion, the annual operation and maintenance was calculated by Michel Baker at $942,610 for the first year which is assumed to begin in 2020. The summary breakdown of the annual O&M cost is provided in Table 19. The detailed cost opinion is provided in Appendix H-4.

TABLE 19. SUMMARY OF NLT OPERATION AND MAINTENANCE COSTS DURING NON-CRITICAL SEASON

Cost Category	Cost
Labor (Based on 10 new positions)	$386,200
Electrical, Gas & Water	$200,240
Chemical Use	$347,170
Lab Analytical (PCB Monitoring)	$9,000
Total O&M Cost (First Year)	**$942,610**

4. A 30-year life cycle cost (LCC) analysis was prepared by Michael Baker to quantify the present value of O&M costs to operate and maintain the NLT during the non-critical season over 30 years. The inflation factor for all categories except labor was set to 2.19% annually which is the average

inflation rate over the past 20 years. The inflation rate for labor was set to 2.5% annually to slightly outpace the average rate of inflation. The discount rate for the present value analysis was set to match inflation at 2.19%. Based on the foregoing, the 30-year LCC yielded a present value cost of $29,782,000.

Trapp's Opinion 6 – City's mitigation actions to reduce/eliminate PCB discharges from City-owned and -operated MS4, CSS, and wastewater treatment plant (RPWRF) will bring reduction of PCB loads from the City to the Spokane River and help to restore the beneficial uses impaired by PCBs.

1. Total PCB load reduction from City's mitigation actions is a sum of PCB load reductions from the City-owned and -operated MS4.
2. City's future mitigation actions of reduction/elimination of stormwater runoff, which were evaluated under the three scenarios, will reduce PCB loads from the City's MS4. As presented in Trapp's Opinion 5, the City will achieve PCB load reduction by reducing/eliminating stormwater discharges from City's MS4 to the river. Estimated daily PCB load in the baseline condition (2007) is 128.943 mg/day and estimated daily PCB load in the future conditions are 0 mg/day, 0.0393 mg/day, and 0.0004 mg/day for the compliance scenarios 1, 2, and 3 respectively. Therefore, potential future PCB load reductions are 128.943 mg/day (100% reduction), 128.90 mg/day (over 99.96% reduction), and 128.94 mg/day (over 99.99% reduction) under the compliance scenarios 1, 2, and 3.
3. In addition to these load reductions, the City's future mitigation measures of reducing/eliminating stormwater discharges under the MS4 compliance scenarios 1 and 3 will result in an outcome equivalent to treating stormwater discharge to the current PCB HHC of 7 pg/L. Furthermore, the City's future mitigation measures under all three scenarios will result in an outcome equivalent to treating stormwater discharges to the old PCB HHC of 170 pg/L.
    a. Estimate annual PCB load in the future conditions are 0 mg/year, 14.35 mg/year, and 0.16 mg/year for the MS4 compliance scenarios 1, 2, and 3 respectively. PCB annual target loads to meet the current and old PCB HHC (7 pg/L and 170 pg/L) are 7.6 mg/year and 183.4 mg/year respectively. The target loads are PCB loads that the City's MS4 would discharge to the river if PCBs in the stormwater could be reduced to the levels of the current and old HHC. The target loads were calculated using the current stormwater discharges presented in Table 8 and the PCB HHC. The PCB loads of the scenarios 1 and 3 are smaller than the 7 pg/L-target load and the PCB loads of all three scenarios are smaller than the 170 pg/L-target load (Table 20).

Table 20. PCB Annual Loads of the Future Conditions under the MS4 Compliance Scenarios and Annual Target Loads for the Current PCB HHC (7 pg/L) and the Old PCB HHC (170 pg/L)

Future Condition Load (mg/year)			Target Load for 7pg/L (mg/year)	Target Load for 170pg/L (mg/year)
Scenario 1	Scenario 2	Scenario 3		

0	14.35	0.16	7.6	183.4

b. As presented in Trapp's Opinion 5.3.g and 5.11, only the MS4 compliance scenario 1 will allow the City to fully comply with the current HHC because the receiving water already exceeds the current HHC and no feasible technology is available to reduce PCBs in stormwater to the level of the current HHC.

4. MS4 PCB load reduction between the baseline condition (2007) and the future condition is 186.84 mg/day (89.92%): Table 20. For the future condition, the compliance scenario 2 and the 2030 projection were used for MS4 for the comparison purpose.
5. As presented in Bowdan's Opinion 3, the City will achieve PCB load reduction from City's CSOs by installing CSO controls that will significantly reduce the frequency and volume of overflows and divert flows to the RPWRF for treatment. The result of the City's effort is the significant reduction of CSOs to the Spokane River by the storage and release of CSOs to the interceptor system and treatment at the RPWRF. Estimated PCB load from City's CSOs in the 2003-2007 baseline is 35.95 mg/day and estimated PCB load from the City's CSOs in the 2030 Projection is 0.37 mg/day. Therefore, future PCB load reduction is 35.58 mg/day (99.0% reduction).
6. As presented Bowdan's Opinion 3, the City will achieve PCB load reduction from the City's RPWRF by: 1) completing construction of improvements that will increase capacity of the primary and secondary treatment systems from 100 MGD to 125 MGD; 2) installation of the new tertiary membrane treatment system (NLT); and 3) performing year-round CEPT to maintain PCB removal efficiencies through primary, secondary, and NLT treatment phases during the both the critical and non-critical seasons. Estimated PCB load in treated effluent from City's RPWRF in the baseline 2001-2007 is 194.6 mg/day and estimated PCB load in 2030 Projection with 50/75 MGD NLT and Post 2030 Projection with 83/125 MGD NLT is 27.5 mg/day and 26.6 mg/day respectively. Therefore, future PCB load reductions are 167.1 mg/day (85.9 % reduction) and 168.0 mg/day (86.3 % reduction).

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Deposition of Mike Coster

Deposition of Marlene Feist

Deposition of Lars Hendron

Michael Baker
INTERNATIONAL

Appendix A CV of J. Michael Trapp

Curriculum Vitae

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Education

Ph.D. Marine Science and Water Quality, University of Miami, 2009

M.S. Chemistry, University of Miami, 2003

B.S. Biology and Chemistry, Florida Southern College, 2000

Professional Experience

Dr. Michael Trapp has extensive experience in environmental monitoring, sampling, chemical analysis, water quality data reporting, and over 18 years of experience in the field of stormwater during which he cultivated a vast working knowledge of regulation and policy. He has been responsible for the development and management of projects to meet local and regional water quality needs, and has supervised and trained technicians, undergraduates, and graduate students in regulatory laboratory and field quality control practices.

Dr. Trapp's research in the field of stormwater related sciences has resulted in numerous conference presentations and peer reviewed publications. As a result, he has been invited to lead multiple workshops on stormwater and monitoring at national and regional conferences.

Experience

Dr. Michael Trapp has acted as the Contract Manager, Project Manager (PM), Quality Assurance (QA) Manager, Chief Scientist, and/or Principal Review for the following ongoing or recent projects:

Stormwater Regulatory Support

- Permit and Time Schedule Order Compliance Support for Metal Discharges - Southern California Edison Company
- San Onofre Nuclear Generating Station Permit Renewal - Southern California Edison Company
- Industrial General Permit Tenant Outreach California Industrial General Permit and Municipal Separate Storm Sewer System Requirements - Port of Los Angeles
- Los Peñasquitos Watershed Master Plan – City of San Diego
- La Pata Avenue Gap Closure Water Quality Management Plan - Orange County
- Trash Amendments Phase 1 Baseline Study Work Plan and Watershed Protection Program - San Diego County
- Total Maximum Daily Loads Development, Technical Feasibility of Implementation Plans, Liability Assessment, and Technical Report Review - Caltrans
- National Pollutant Discharge Elimination System Phase II Stormwater Regulation – Caltrans

- Municipal Separate Storm Sewer Systems Municipal Permit Assistance – Caltrans
- Stormwater Policy and Permit Support Services, Annual Stormwater Program Reporting – Caltrans
- State Parks Dust Control and Treatment Services - California Department of Parks and Recreation
- State Parks Surface Water and National Pollutant Discharge Elimination System Support Services - California Department of Parks and Recreation
- Peer Review and Professional Advising – Caltrans
- Facility Pollution Prevention Plans – Caltrans
- Municipal Waterways Maintenance Plan Support – City of San Diego
- Channel Maintenance Program – City of San Diego
- Watershed Assessment Management Plan Support – City of San Diego
- Stormwater Maintenance Program – City of San Diego
- Miramar Landfill Stormwater Implementation Plan – City of San Diego
- Stormwater Standards Manual Update – City of San Diego
- City Wide Pipe Assessment and Repair Support - City of San Diego
- Street Sweeping and Aerial Deposition Research - City of San Diego
- Street Sweeping Update to the Union City Best Management Practices Street Sweeping Program – City of Union City
- Alternative Compliance Program - City of San Diego
- Port of San Diego Trash Amendment Support - San Diego Unified Port District
- Stormwater Permit Implementation – Orange County
- Aerial Deposition Research - Port of Los Angeles
- Street Sweeping Research - Port of Los Angeles
- Water Quality Improvement Program - Port of Los Angeles
- Big Creek Powerhouse No. 1 Wastewater Treatment Plant Waste Discharge Requirements Permit - Southern California Edison Company

Environmental Monitoring

- Assessment of Discharges of Contaminated Sediments into San Diego Bay - City of San Diego Economic Development.
  - Campbell Shipyard Sediment Support and Monitoring - City of San Diego
  - Tenth Avenue Marine Terminal Sediment Support and Monitoring - City of San Diego
  - LHE Sediment Support and Monitoring - City of San Diego
  - Continental Maritime Sediment Support and Monitoring - City of San Diego
- Monitoring and Assessment of Contaminated Sediment into San Diego Bay - Caltrans
- Areas of Special Biological Significance Monitoring, Six Caltrans Districts Statewide - Caltrans

- Wet Weather Municipal Separate Storm Sewer System National Pollutant Discharge Elimination System Outfall Monitoring - Port of Long Beach
- Malibu Creek Watershed Enhanced Watershed Management Program and Coordinated Integrated Monitoring Plan - Confidential Client
- Southern California Monitoring Coalition Low Impact Development Best Management Practices Effectiveness Study - San Bernardino County
- San Diego Regional Bacteria Reference Beach Special Study - Orange County
- Allied Garden Rain, Garden Best Management Practices Effectiveness Assessment, Water Quality Monitoring - City of San Diego Economic Development
- Cabrillo Heights Rain Garden Best Management Practices Effectiveness Assessment and Water Quality Monitoring - City of San Diego Economic Development
- La Pata Avenue Gap Closure Best Management Practices Effectiveness Monitoring – Orange County Public Works
- Camino Del Rio Best Management Practices Effectiveness Monitoring – City of San Clemente
- Staff Augmentation for Dry Weather Monitoring - Orange County Public Works
- Logan Heights Low Impact Development Design - City of San Diego
- Naval Training Center Boat Channel Phase III Sediment – City of San Diego
- Bacterial Total Maximum Daily Load Support - City of San Diego
- Jurisdictional Runoff Management Plan Annual Reporting - City of San Diego
- San Diego Unified Port District Best Management Practices Monitoring - San Diego Unified Port District
- Santa Ysabel and Santa Maria Creeks Nutrient Loading Study – County of San Diego
- Chesapeake Bay Total Maximum Daily Load Action Plan for Navy Installations – US Navy/NAVFAC
- Multimedia Environmental Compliance Support – US Navy/NAVFAC
- Stormwater Planning and Logistics Services - US Navy/NAVFAC
- Ocean Hills Country Club Groundwater Discharge Permitting - Ocean Hills Country Club Homeowners Association
- Ocean Beach Rain Events Monitoring - San Diego County
- Salt Lake City Stormwater Program Support - Utah Department of Transportation
- Piru Stormwater Capture Monitoring - Ventura County
- Water Quality Monitoring - City of San Diego Economic Development

Expert Witness Experience

Dr. Michael Trapp has given expert witness testimony in the case of City of San Diego v. Monsanto, et al.

Past Project Experience

- Surf Monitoring for Regulatory Fecal Indicator Bacteria at Myrtle Beach and North Myrtle Beach, South Carolina
- Design, Construction, and Monitoring for Long Bay Hypoxia Consortium, Myrtle Beach and North Myrtle Beach, Horry County, Surfside, and Georgetown, South Carolina.
- Waccamaw River Ambient Water Quality Monitoring Program, Horry and Georgetown Counties, South Carolina.
- Development of a Pilot Investigative Approach to Remediate Bacterial Source Impairments Along the Grand Strand.
- Development of A Multi-Tracer Microbial Source Tracking Protocol Centering Around Host Specific QPCR Genetic Markers, Planning Assistance to States, Horry and Georgetown Counties, South Carolina - U.S. Army Core of Engineers.
- Development/Adoption of Microbial Source Tracking and Stormwater Management Tools To Remediate Bacterial Source Impairments Along the Grand Strand - Grand Strand, South Carolina Communities and USACE.
- National Oceanic and Atmospheric Administration National Estuarine Research Reserve System Science Collaborative - Determining the Role of Estuarine 'Swashes' on Water Quality Impairment along the Grand Strand of South Carolina: Impacts of Land Use and Stormwater Runoff, Horry and Georgetown Counties, South Carolina.
- Multi-Disciplinary Watershed Bacteria Source Tracking, Briarcliff Acres, South Carolina.
- GEOTraces Aerosol inter-comparison, Miami, Florida.
- BarDEx. II Barbados Dust Experiment, Barbados, West Indies.
- BarDEx. I Barbados Dust Experiment, Barbados, West Indies.
- P16 North, Global Ocean Repeat Hydrography Study, Tahiti, French Polynesia, Honolulu, Hawaii
- Florida Bay Carbonate and Trace Metal Study, Florida Keys.
- Bahamas Banks Carbonate and Whiting Study, Big Bahamas Banks, Bahamas.
- A16S Global Ocean Repeat Hydrography Study - Punta Arenas, Chile, Fortaleza, Brazil.
- A16N Cruise Global Ocean Repeat Hydrographic Study, Madeira, Portugal, Natal Brazil.
- Bahamas Banks Carbonate and Whiting Study, Big Bahamas Banks, Bahamas.

Professional History

Michael Baker International, Project Manager, 2014-Present

Coastal Carolina University, Laboratory Director, Environmental Quality Lab, 2010-2014

U.S. Environmental Protection Agency, SCEP Chemist, 2009- 2010, National Enforcement and Investigation Center

University of Miami, Graduate Research Associate, 2002 – 2009

Chemist Novartis / Cardinal, 2000-2002

Honors and Awards

Key to the City of New Port Richey, Florida - Community Service

Maytag Fellowship in Chemistry, University of Miami

SCEP Internship – EPA National Investigation and Enforcement Center

Publications, Presentations and Public Outreach/Technical Advising Presentations

J.M. Trapp; F.J. Millero; J.M. Prospero. Trace metal deposition and iron solubility and speciation in tropical and subtropical precipitation. Marine Chemistry. (In Preparation 2013).

J.M. Trapp; A. Dimkovikj. Empirical Relationships Between qPCR Based Host Specific Assays and Regulatory Fecal Indicator Bacteria in Fecal Matter. Env. Microbiology (In Preparation 2013).

M.K. Curtis & **J.M. Trapp**. An investigation into the prevalence and quantification of Escherichia coli in drainage basin sediments and their role as a source of FIB entering Withers Swash, Myrtle Beach, SC, Env Microbiology. (2013).

J.M. Trapp, and S. Libes, E.J. Burge, J. Wood. Use of Host Specific Microbial Source Tracking Data to Direct Point and Nonpoint Source Watershed Remediation Efforts. Proceeding of StormCon 2013, Aug 19-22, 2013. Myrtle Beach, SC USA. (2013)

L.M. Zamora1, J.M. Prospero, D.A. Hansell, **J.M. Trapp**, Atmospheric P deposition to the subtropical North Atlantic: sources, properties, and relationship to N deposition. Journal of Geophysical Research-Atmospheres. (2012). DOI: 10.1002/jgrd.50187

J.M. Trapp, S. Libes, E. Burge. Application of qPCR Technologies in Stormwater Source Tracking and Determination of Host Contributions of Fecal Indicator Bacteria. Proceedings of the 2012 South Carolina Water Resources Conference, October 10-11, 2012, at the Columbia Metropolitan Convention Center. (2012)

S. Libes, **J.M. Trapp**, S.K. Kindelberger, and D. Doremus (2012) Long Bay Hypoxia Monitoring Consortium. Proceedings of the 2012 South Carolina Water Resources Conference, October 10-11, 2012, at the Columbia Metropolitan Convention Center. (2012)

J.M. Trapp, E. Burge, S. Libes, and A. Sturgeon; Use of qPCR Technologies in Stormwater Regulatory Quantification and Watershed Source Tracking of Fecal Indicator Bacteria. Proceeding of the South Carolina Environmental Conference, 9pp., March 10-14, 2012. Myrtle Beach, SC USA. (2012)

L.M. Zamora, J.M. Prospero, D.A. Hansell, **J.M. Trapp**, A. Landolfi, A. Oschlies, F. Dentener Phosphorus stress induced by atmospheric deposition to the surface waters of the subtropical North Atlantic, SOLAS Newsletter, 13: 34-36, www.solas-int.org/news/newsletter/files/Issue13readonscreen.pdf. (2011).

E. Breitbarth, E.P. Achterberg, M.V. Ardelan, A.R. Michael Baker, E. Bucciarelli, F. Chever, P.L. Croot, S. Duggen, M. Gledhill, M. Hassell, C. Hassler, L.J. Hoffmann, K.A. Hunter1, D.A. Hutchins, J. Ingri, T. Jickells, M.C. Lohan, M.C. Nielsdottir, G. Sarthou, V. Schoemann, **J.M. Trapp**, D.R. Turner, and Y. Ye. Iron biogeochemistry across marine systems at changing times conclusions from the workshop held in Gothenburg, Sweden (14–16 May 2008). Biogeosciences.(2010).

Trapp, J.M., F.J. Millero, and J.M. Prospero. Trends in the solubility of iron in dust-dominated aerosols in the equatorial Atlantic trade winds: Importance of iron speciation and sources, Geochem. Geophys. Geosyst., 11, Q03014, doi:10.1029/2009GC002651. (2010).

J.M. Trapp, J. Prospero, F.J. Millero. Temporal Variability of the Elemental Composition of African Dust Measured in Trade Wind Aerosols at Barbados and Miami. Marine Chemistry. doi:10.1016/j.marchem.2008.10.004 (2008),

J.M. Trapp, F.J. Millero. The Oxidation of Iron (II) with Oxygen in NaCl Brines. Journal of Solution Chemistry. DOI 10.1007/s10953-007-9192-8 (2007).

J.M. Trapp, and S. Libes, E.J. Burge. Withers Swash Microbial Source Tracking Program. QAPP. 78p. US ACoE. (2012).

E. Burge, **J.M. Trapp**, S. Libes. Report for Task 1: Genotypic tracer development. Planning Assistance to States Project: Stormwater Management Planning: Development of a Pilot Investigative Approach to Remediate Bacterial Source Impairments along the Grand Strand (2012)

J.M. Trapp. Waccamaw River Water Quality Monitoring Program QAPP. 58p. SC-DHEC. (2011).

F.J. Millero, T. Graham, M. Chanson, **J.M. Trapp**, B. West, P. Gibson and D.Pierrot, Global Ocean Repeat Hydrography Study: pH and Total Alkalinity Measurements in the North Pacific P16N February - March 2006, University of Miami Technical Report, RSMAS-2006-02, 50 pp. (2006).

F.J. Millero, T. Graham, M. Chanson, W. Hiscock, **J.M. Trapp** and D. Pierrot, Global Ocean Repeat Hydrography Study: pH and Total Alkalinity Measurements in the South Atlantic A16S January – February 2005, University of Miami Technical Report, No. RSMAS-2005-04. (2005).

F.J. Millero, T. Graham, X. Zhu, W. Hiscock, **J.M. Trapp**, D. Valdes and V. Koehler, Global Ocean Repeat Hydrographic Study: pH and Total Alkalinity Measurements in the North Atlantic (A16N Cruise June - August 2003), University of Miami Technical Report, No. RSMAS-2004-05. (2004).

J. M Trapp. Application of Host Specific Tracers to Microbial Source Tracking Programs in Tidal Creek watersheds and Stormwater Drainage Basins. 12th Annual Headwaters to Ocean (H2O) May 27-29, 2014, San Diego, CA. Invited Speaker.

Libes, S., E.J. Burge, **J.M. Trapp**. Building local capacity for microbial source tracking in the Myrtle Beach Urbanized Area. 2014 Water Microbiology Conference: Microbial contaminants from watersheds to human exposure. May 5-7 2014, Chapel Hill, NC. Oral presentation.

Dimkovikj A., **J.M. Trapp**. A Comparison of the Relationship Between Regulatory Fecal Indicator Bacteria and Host Specific Genetic qPCR markers in Common Fecal Pollution. Poster presentation.

Burge, E.J., **J. M Trapp**, S.M. Libes, and J. Wood. Development of a collaborative tool for identification of fecal bacteria sources in coastal waters. 22nd Biennial Conference of the Coastal and Estuarine Research Federation. November 3 – 7 2013 San Diego, CA. Oral presentation.

J.M. Trapp, and S. Libes, E.J. Burge, J. Wood. Use of Host Specific Microbial Source Tracking Data to Direct Point and Nonpoint Source Watershed Remediation Efforts. StormCon 2013, Aug 19-22 2013. Myrtle Beach, SC USA. Oral presentation.

J.M. Trapp. How the Myrtle Beach Urbanized Area Used its Collaborative Education Outreach Program to Develop Water Quality Monitoring to Meet NPDES Phase II Stormwater Requirements - Multiple Tracer Microbial Source StormCon 2013, Aug 19-22 2013. Myrtle Beach, SC USA. Oral presentation and panel discussion.

M.K. Curtis, and J.M. Trapp Examining drainage basin sediments as an additional source of microbial contamination within the Withers Swash drainage basin, Myrtle Beach, SC. South Carolina Environmental Conference. March 10 - 12, 2013. Myrtle Beach, SC. Oral presentation.

J.M. Trapp, S. Libes, E.J. Burge, J. Wood and S. Adera. Use of Host Specific Fecal Indicator Bacteria Microbial Source Tracking Data to Suggest Remediation Efforts in Withers Swash, Myrtle Beach, SC. South Carolina Environmental Conference. March 10 -12, 2013. Myrtle Beach, SC. Oral presentation.

S.A. Kindelberger, D.R. Doremus, S.M. Libes, **J.M Trapp**. New Approaches to Terrestrial-based Ocean Monitoring Platforms. ASLO 2013 Aquatic Sciences Meeting. 17-22 February 2013. New Orleans, Louisiana. Oral presentation.

Mickey, R.C., Xu, K, Libes, S., **Trapp, J.M**. A Study of Resuspended Material Along Sediment -Water Iinterface on the Texas-Louisiana Continental Shelf Using Gust Erosion Microcosm System. ASLO 2013 Aquatic Sciences Meeting. 17-22 February 2013. New Orleans, Louisiana. Oral presentation.

J.M. Trapp, S. Libes, E. Burge. Application of qPCR Technologies in Stormwater Source Tracking and Determination of Host Contributions of Fecal Indicator Bacteria. Proceedings of the 2012 South Carolina Water Resources Conference, October 10-11, 2012, at the Columbia Metropolitan Convention Center. Oral presentation.

M.K. Curtis, **J.M. Trapp** An investigation into the prevalence, quantity, and survival of Escherichia coli in stormwater basin sediments of Withers Swash Myrtle Beach, SC. Proceedings of the 2012 South Carolina Water Resources Conference, October 10-11, 2012, at the Columbia Metropolitan Convention Center. Poster presentation.

S. Libes, **J.M. Trapp**, S.K. Kindelberger, and D. Doremus. Long Bay Hypoxia Monitoring Consortium. Proceedings of the 2012 South Carolina Water Resources Conference, October 10-11, 2012, at the Columbia Metropolitan Convention Center. Oral presentation.

S. Libes, **J.M. Trapp**, and S. Kindelberger. Deployment of Data Sondes from Fishing Piers To Monitor Nearshore Hypoxia in Long Bay, South Carolina. 2012 National Water Quality Monitoring Conference. April 30 – May 4 2012. Portland, Oregon. Oral presentation.

J.M. Trapp, E. Burge, S. Libes, and A. Sturgeon; Use of qPCR Technologies in Stormwater Regulatory Quantification and Watershed Source Tracking of Fecal Indicator Bacteria, South Carolina Environmental Conference, March 10-14 2012. Myrtle Beach, SC USA. Oral presentation.

J.M. Trapp, S. Libes, and S. Kindelberger. Nearshore Hypoxia in the Coastal Waters of Long Bay, South Carolina; TOS/ASLO/AGU Ocean Sciences Meeting, February 20-24 2012., Salt Lake City, UT, USA. Poster presentation.

J.M. Trapp, S. Libes; Building a Water Quality Consortium in the Grand Strand of Northeastern South Carolina and South Eastern North Carolina; Oral presentation, TOS/ASLO/AGU Ocean Sciences Meeting, February 20-24 2012., Salt Lake City, UT, USA. Oral presentation.

L.M. Zamora, D.A. Hansell, J.M. Prospero, and J**.M. Trapp**; Atmospheric Phosphorus Deposition to the Subtropical North Atlantic: Sources, Properties, and Relationship to Nitrogen Deposition; ASLO Aquatic Sciences Meeting, 13-18 February 2011, San Juan, Puerto Rico, USA. Oral presentation.

R. Karkowski, S.M. Libes, **J.M. Trapp** ; A Multi-Disciplinary Watershed-Based Approach to Bacteria Source Tracking Within the Grand Strand of South Carolina. SC Water Resources Conference. Columbia, SC. October, 2010. Oral presentation.

K. Semon, V. Paul, M. Clementz, **J.M. Trapp**, L.-A. Hayek. Tracing Sources and Patterns in Cyanobacteria Bloom Impacts on Belizean and South Florida. Benthic Communities. 38 th annual Benthic Ecology Meeting. Corpus Christi, TX. March 4-7, 2009. Oral presentation.

J.M. Trapp, J. Prospero, F.J. Millero. Factors effecting iron solubility and speciation in aerosols collected in Barbados on summer trade winds. Marine iron biogeochemistry across marine systems at changing times Workshop. University of Gothenburg, Sweden. 14 -16 May 2008. Poster presentation.

K. Semon, V. Paul, M Clementz, **J.M. Trapp**, K. Arthur. Evaluation of Biotic and Abiotic Factors that Facilitate and Maintain Cyanobacteria Blooms and Phase Shifts in Coral Communities. The 11th International Coral Reef Symposium, Fort Lauderdale, Florida, July 7-11, 2008. Oral presentation.

J.M. Trapp, F.J. Millero, J. Prospero. Trace metal concentration in Trade Wind aerosols collected over Barbados and Miami. 2007. Eos Trans. AGU, 88(52), Fall Meeting. San Francisco, CA USA December 2007. Poster presentation.

J.M. Trapp, F.J. Millero. The oxidation of Iron(II) with oxygen in NaCl brines. ACS, Chemical Science Symposium. Nova Southeastern University, Fort Lauderdale 2005. Poster presentation.

J.M. Trapp. Sources and Factors affecting aerosol Nutrient and Trace Metal Deposition. Invited Speaker: Smithsonian Institute, Marine Science Network. Ft Pierce, FL. March 13, 2009.

J.M. Trapp. Atmospheric Aerosols: Production, Transport, and Deposition. Invited speaker: Chemistry Lecture Series. Humboldt State University, February 1, 2008

J.M. Trapp. Interview. WMBF & WPDE. Deployment of hypoxia water quality sensors at Cherry Grove Pier. North Myrtle Beach, SC July, 2012

J.M Trapp, Libes, S., E. Burge. Preliminary and Ongoing Microbial Source tracking results from Wither Swash Myrtle Beach, SC. US-ACOE Stakeholders meeting. August, 1 2012.

Libes, S., **J.M. Trapp**. Source Tracking of Pollutant Bacteria using qPCR: Preliminary findings & Projects underway. Invited presentation. Horry County Stormwater Advisory Board May 29 2012 Conway, SC.

J.M Trapp, Libes, S., Source Tracking of Pollutant Bacteria using qPCR: Preliminary findings & Projects underway. Invited presentation. Coastal Waccamaw Stormwater Education Consortium. June 9, 2011, Conway, SC.

Libes, S., E. Burge, and J**.M. Trapp** Development of genotypic tracers of pollutogen sources for northeastern South Carolina. Invited presentation to Horry County Stormwater Advisory Board, April 26, 2011, Conway, SC

J.M. Trapp. Update on Regulatory FIB change from Fecal Coliforms to e. coli. Invited presentation. Coastal Waccamaw Stormwater Education Consortium. December 8, 2010, Conway, SC.

Teaching Experience

- Lecturer of Marine Science, Coastal Carolina University, 2010- 2014
- Graduate Student / Teaching Assistant, University of Miami, 2002-2010
- Adjunct Professor, Miami Dade College, 2004 – 2007

Specialized Experience

- NOAA NEERs, Determining the role of estuarine 'swashes' on water quality impairment along the Grand Strand of South Carolina: Impacts of land use and Stormwater runoff. Myrtle Beach, SC, September 2010- December 2013.
- Multi-Disciplinary Watershed Bacteria Source Tracking. Briarcliff Acres, SC, 2010
- GEOTraces, Aerosol Inter-comparison, Miami, Florida, September 2008.
- BarDEx. Barbados Dust Experiment. Barbados, West Indies. July –September 2008.
- BarDEx. Barbados Dust Experiment. Barbados, West Indies. August –September 2007.
- P16 North, Global Ocean Repeat Hydrography Study. Tahiti, French Polynesia – Honolulu, Hawaii. February - March 2006,
- Florida Bay Carbonate and Trace Metal Study. Florida Keys. August 2005
- Bahamas Banks Carbonate and Whiting Study. Big Bahamas Banks, Bahamas. May 2005
- A16S Global Ocean Repeat Hydrography Study, Punta Arenas, Chile – Fortaleza. Brazil. January – February 2005
- A16N Cruise Global Ocean Repeat Hydrographic Study. Madeira, Portugal – Natal Brazil. June - August 2003
- Bahamas Banks Carbonate and Whiting Study. Big Bahamas Banks, Bahamas. May 2003

Professional Affiliations

American Chemical Society (ACS)

American Geophysical Union (AGU)

California Stormwater Quality Association (CASQA)

Lambda Chi Alpha Fraternity

Sigma Xi Scientific Research Society

Water Environment Federation (WEF)

Michael Baker INTERNATIONAL

Appendix B CV of Joel E. Bowdan III

Curriculum Vitae

9755 Clairemont Mesa Boulevard

San Diego, CA 92124

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Joel E. Bowdan III, P.E.
Technical Manager

Education

B.S. Civil Engineering, Lawrence Technological University, 1993

Professional Licenses

Professional Engineer – Civil, Michigan, 1997 – Present

Professional Engineer – Civil, California, 2007 - present

Professional Experience

Mr. Joel Bowdan is an experienced registered professional civil engineer with more than 26 years of experience in planning and design of water and wastewater infrastructure including pipelines, lift stations, booster stations, production wells, storage tanks, treatment facilities, and combined sewage overflow elimination facilities. Mr. Bowdan is responsible for project management, design supervision, contract administration, client interaction and development, and personnel management. His expertise includes complex pumping and piping system layout, hydraulic design, groundwater supply and treatment design, brackish water reverse osmosis membrane desalinization design, electrodialysis reversal treatment for disinfected tertiary treated reuse water, alternative treatment for cooling tower systems, other process related design, and construction phase assistance including start-up and operation of pumping and treatment facilities. Mr. Bowdan coordinates all engineering support disciplines (civil, architectural, structural, process, mechanical, electrical, and I&C) during project design and construction phases.

In addition to his expansive, real-world design experience, Mr. Bowdan has also prepared numerous technical memoranda, feasibility studies, and preliminary design reports to examine best available treatment technologies for various water and wastewater related industrial and municipal projects.

Experience

Mr. Bowdan has acted as the Project Manager (PM), Quality Assurance (QA) Manager, Project Engineer (PE) and/or Designer of Record (DOR) for the following ongoing, recent, or past projects while at RBF/Michael Baker or Hubbell, Roth & Clark, Inc:

Water, Recycled Water, and Wastewater Related Projects

- Upper Valle De Los Caballos (UVDC) Regional Pump Station and Chlorine Contact Basin, Temecula, California. Rancho California Water District.
- Domestic and Industrial Waste Lagoon Treatment Evaluation and Improvements Design, Undisclosed Location. Undisclosed Client.
- Ralph W. Chapman Water Reclamation Facility Solids Handling Study, Spring Valley, California. Otay Water District.

- Chino Hills 123-TCP Removal Project (Granular Activated Carbon (GAC)), Chino Hills, California. City of Chino Hills.
- Aeration Tank and Clarifier Replacement, San Clemente Island, California. Naval Facilities Southwest Division.
- Power House Water Softener Replacement D/B, Oxnard, California. Dignity Health – St. John's Regional Medical Center.
- Terminal Stormwater Reuse Treatment System D/B, San Diego, California. San Diego International Airport
- Pechanga North Cooling Towers and South Central Plant Cooling Tower Recycled Water Treatment, Temecula, CA. Pechanga Development Corporation.
- Kaiser San Diego Central Hospital Energy Center Cooling Tower and Domestic Hot Water Treatment Systems, San Diego, CA. Kaiser Permanente.
- South Bay Water Reclamation Plant Demineralization D/B Project, San Diego, California. City of San Diego.
- Phase 2 - Aeration Basins 1 through 8 Modifications, Hesperia, California. Victor Valley Wastewater Reclamation Authority.
- Phase I - Aeration Piping Modifications, Hesperia, California. Victor Valley Wastewater Reclamation Authority.
- Well 27 Iron & Manganese Removal System QA/QC, Southgate, CA. City of Southgate.
- Brackish Water Reverse Osmosis Water Treatment Plant, Pomona, California. California State Polytechnic University, Pomona.
- Cooling Tower Treatment Study, Oceanside, California. Genentech, Inc.
- Cooling Tower Recycled Water Treatment Study, Pomona, CA. California State Polytechnic University, Pomona.
- Avalon Wastewater Treatment Plant New Centrifuge Project, Santa Catalina Island, CA. City of Avalon.
- Amylin Recycled Water Retrofits & Cooling Tower Treatment, San Diego, CA. Amylin Pharmaceuticals.
- Rail Road Ground Water Filtration Plant Expansion and Arsenic Removal, Sacramento, CA. Elk Grove Water District.
- San Pasqual Brackish Water Temporary Desalination Demonstration, San Diego, California. City of San Diego.
- Sewage Ponds and Main Pumping Station Investigation and Study, Lemoore, CA.
- South Bay Water Reclamation Plant Demineralization Project, San Diego, California.
- Coronado Recycled Water Feasibility Study, Coronado, California. City of Coronado.
- Geothermal Recycled Water Conceptual Design, Brawley, California. Client Undisclosed
- Geothermal Brawley Filtration Treatment, Brawley, California. Client Undisclosed
- Ground Water Arsenic Removal Studies, Sacramento, California. California American Water.
- Ryan Ranch Iron and Arsenic Removal System, Monterey, California. California American Water.
- Ambler Park Iron and Arsenic Removal System, Monterey, California. California American Water.
- Monterey Bay Regional Seawater Desalination (formerly Coastal Water Project) Preliminary Design and Program Management, Monterey, California. California American Water.

- San Onofre/Camp Pendleton Seawater Desalination Feasibility Studies, Camp Pendleton, California. San Diego County Water Authority
- Backup Water Supply Project Feasibility Study, Lemoore NAS, California. Naval Facilities Southwest Division.
- Comprehensive Planning Study, Monterey, California. California American Water.
- Water System Capital Improvements Design – Iron/Arsenic Removal Facilities, Independence Township, Michigan. Independence Township.
- Water System Capital Improvements Study, Independence Township, Michigan. Independence Township.
- Ground Water iron Removal Filtration Plant Expansion, South Lyon, Michigan.
- Well House No. 5, South Lyon, Michigan. City of South Lyon
- Potable and Industrial Water Treatment System Replacement, Parma, Michigan. Michigan Automotive Compressor Plant.
- Pollution Controls Facilities (Phases I, II, and III), Southfield, Michigan. City of Southfield.
- Ford Wixom Assembly Plant Industrial Waste Treatment Plant, Wixom, Michigan. Ford Motor Company.
- Ford Sterling Heights Industrial Waste Treatment Plant Optimization Study, Sterling Heights, Michigan. Ford Motor Company.
- Buick City Wastewater Characterization Study, Flint, Michigan. General Motors
- Industrial Wastewater Treatment Plant, Fremont, California. New United Motor Manufacturing, Inc.

Combined Sewage Overflow Facilities

- CSO Elimination Monitoring Program, Oakland County, Michigan. Oakland County Drain Commissioner.
- CSO Tunnel, Weir and Baffle Structure, and Dewatering Pump Station, East Lansing, Michigan. City of East Lansing.
- Birmingham Retention Treatment Basin Design, Oakland County, Michigan. Oakland County Drain Commissioner.
- Bloomfield Hills Retention Treatment Basin Design, Oakland County, Michigan. Oakland County Drain Commissioner.
- Acacia Park Treatment Basin Design, Oakland County. Oakland County Drain Commissioner.
- Saginaw CSO Elimination Program, Saginaw, Michigan. City of Saginaw.

Expert Witness Experience

Joel Bowdan has not provided trial or deposition testimony in the past four years.

Professional History

Michael Baker International, San Diego, CA, Technical Manager, 2013-Present

RBF Consulting, San Diego, CA, Senior Associate/Project Manager, 2004-2013

Hubbell, Roth & Clark Inc., Bloomfield Hills, MI, Associate, 1993-2004

Honors and Awards

Outstanding Civil Engineering Project – city of San Diego South Bay Water Reclamation Plant Demineralization. ASCE San Diego Section. September 2017

Outstanding Sustainable Project of the Year - Cal Poly Pomona RO WTP. ASCE Metropolitan Los Angeles Section. September 2015

Outstanding Public Sector Civil Engineering Project of the Year - Cal Poly Pomona RO WTP. ASCE San Bernardino-Riverside Branch. June 2015.

Outstanding Civil Engineering Project - Water Treatment. ASCE San Diego Section. 2010.

Young Civil Engineer of the Year Award. ASCE Michigan Section Southeastern Branch. 2002.

Publications, Presentations and Public Outreach/Technical Advising Presentations

Bowdan, J. *Reverse Osmosis Water Treatment Plant Cal-Poly Pomona*. CalDesal Annual Conference. San Diego, CA. February 2017

Bowdan, J. *Keys to Successful Industrial Water Reuse*. WateReuse San Diego Chapter Meeting. November 2016.

Bowdan, J., Rahimian-Pour, A. Michael Baker Webinar. *Cooling Tower Treatment and Water Conservation*. October 2016.

Bowdan, J. *Overview of New SWCRB OWTS Policy and San Diego County LAMP*. Michael Baker Institute. San Diego, CA. 2016.

Bowdan, J., Layton, R. *Evaluation of Historical Reuse Applications and Summary of Technical/Regulatory Issues and Related Solutions for Industrial Reuse Projects*. Publication No. WRRF 12-03. WateReuse Research Foundation, Dec. 2015. Web.

Bowdan, J., Sekeroglu S. *Water Reuse*. RBF Institute. San Diego, CA. 2014.

Antolovich, A., **Bowdan, J.**, Layton, R. Industrial Water Reuse Webinar. *Taking Industrial Reuse to the Next Level Now*. WateReuse Research Foundation. 2014.

Bowdan, J. *Recirculating Cooling Towers Using Recycled Water - A Biotech Firm's Story*. WateReuse Commercial, Industrial, Institutional Workshop, IRWD, CA. 2013.

Bowdan, J., Rahimian, A.; 2012. *Going Green Utilizing a Pretreatment Process for Recycled Water use in Cooling Towers.* WateReuse CA Annual Conference, Sacramento, CA.

Bowdan, J., Findlay, P. Pretreatment Issues for Seawater and Brackish Groundwater. 2010 Border Governors' Binational Desalination Conference, San Diego, CA. May 2010

Bowdan, J., Sekeroglu, S., Yarkin, M.; 2010. *Local Ground-water Source Opportunities in the San Pasqual Valley by BW Membrane Desalination*. WateReuse CA Annual Conference, San Diego, CA

Bowdan, J., Rahimian, A., Sekeroglu, S., Yarkin, M.; 2010. *Performance of Various Halophytes for Concentrate Volume Reduction*. WateReuse CA Annual Conference, San Diego, CA

Bowdan, J., Sekeroglu, S. San Pasqual Brackish Groundwater Desalination Demonstration Project: Concentrate Management. ASCE Younger Members Forum, San Diego, CA. October 2009

Teaching Experience

- Course Instructor, Professional Engineers License Exam Review Course – Environmental, Michael Baker International, 2017 – 2018.

Professional Affiliations

American Membrane Technology Association (AMTA)

American Society of Civil Engineers (ASCE)

American Water Works Association (AWWA)

Chi Epsilon – Civil Engineering Honor Society, LTU

Tau Beta Pi – Engineering Honor Society, LTU

WateReuse Association

Michael Baker
INTERNATIONAL

Appendix C Fee Rate

DEPOSITION AND TRIAL TESTIMONY RATE

Effective January 2017 through December 2019

Michael Trapp's and Joel Bowdan's time spent on expert witness deposition and trial testimony activities shall be charged at $300 per hour.

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Appendix D WinSLAMM Modeling Work Files

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Appendix E Discharge Calculation Spreadsheets

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Appendix F BMP Sizing Summary Calculations

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Appendix G MS4 Costs Calculations

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Appendix H (H-1 through H-6) RPWRF/CSO Calculations